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Independent Verification Sampling and Analysis Plan for Building 779 Cluster

July 1999

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U.S. Department of Energy

Work Performed Under DOE Contract Number DE–AC13–96GJ87335 for the U.S. Department of Energy

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Rocky Flats Environmental Technology Site
Building Decontamination & Decommissioning Independent Verification Project

Independent Verification Sampling and Analysis Plan for Building 779 Cluster

July 1999

Prepared for
U.S. Department of Energy
Rocky Flats Operations Office
Grand Junction Office

Prepared by
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Grand Junction, Colorado

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Acronyms and Abbreviations

Am-241	americium-241
ANSI	American National Standards Institute
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CLP	Contract Laboratory Program
cm	centimeter(s)
cpm	counts per minute
CRDL	contract required detection limit
cm^2	square centimeter(s)
Co-57	cobalt-57
Co-60	cobalt-60
Cs-137	cesium-137
CV	coefficient of variation
D&D	decontamination and decomissioning
DCGL	derived concentration guideline level
$DCGL_{EMC}$	derived concentration guideline level-elevated measurement comparison
$DCGL_{W}$	derived concentration guideline level-average concentration
DOE	U.S. Department of Energy
dpm	disintegration(s) per minute
DQA	data quality analysis
DQI	data quality indicator
DQO	data quality objectives
DU	depleted uranium
EPA	U.S. Environmental Protection Agency
Fe-55	iron-55
g	gram
GM	Geiger-Mueller
ft^2	square foot (feet)
GJO	Grand Junction Office
H-3	tritium
HEUN	highly enriched uranyl nitrate
H_o	null hypothesis
HVAC	heating, ventilation, and air conditioning
Inc.	incorporated
IV	independent verification
IVC	independent verification contractor
IVP	independent verification program
keV	kilo electron-volt(s)
LCS	laboratory control standard
LBGR	lower bound of the gray region
LLC	limited liability corporation
m	meter(s)
MARSSIM	Multi-Agency Radiation Survey and Site Investigation Manual
MDA	minimum detectable activity
MDC	minimum detectable concentration
meV	mega electron-volt(s)
mg	milligrams

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mm	millimeter(s)
m^2	square meter(s)
NIST	National Institute of Standards and Technology
OU	operable unit
P-10	instrument counting gas (90 percent argon, 10 percent methane)
Pa-234m	Protactinium-234, meta-stable
pCi	picoCurie(s)
PRP	primary responsible party
Pu-238	plutonium-238
Pu-239	plutonium-239
Pu-240	plutonium-240
Pu-241	plutonium-241
QA	quality assurance
QAPP	Quality Assurance Program Plan
QAPjP	Quality Assurance Project Plan
QC	quality control
r^2	coefficient of determination
RFETS	Rocky Flats Environmental Technology Site
RFFO	Rocky Flats Field Office
RMRS	Rocky Mountain Remediation Services
SAP	Sampling and Analysis Plan
Sr-90	strontium-90
TBq	teraBecquerel(s)
Th-234	thorium-234
TRU	transuranic
µs	microsecond
UCL_{95}	95 percent upper confidence limit
VDC	volts direct current
vs.	versus
WGP	Weapons Grade Plutonium
WRS	Wilcoxon Rank Sum
WSRIC	Waste Stream and Residue Identification and Characterization
°C	degrees Celcius
°F	degrees Fahrenheit

1.0 Introduction

This Independent Verification (IV) Sampling and Analysis Plan (SAP) provides guidance for data collection to independently assess and verify the results of the U.S. Department of Energy (DOE) Contractor's final status surveys for the Building 779 Cluster located on the Rocky Flats Environmental Technology Site (RFETS) at State Highway 93 and Cactus, Rocky Flats, Colorado. (Figure 1–1)

To achieve the goal of independence in the final verification process, the DOE Rocky Flats Field Office (RFFO) has retained a neutral company, MACTEC–ERS, specializing in radiological measurement, risk-assessment, decontamination and decommissioning, and environmental remediation, to be the Independent Verification Contractor (IVC). The IVC will employ the Derived Concentration Guideline Levels (DCGLs) developed by the Rocky Flats Contractor, Kaiser-Hill Company, LLC, et al (hereafter referred to as the Contractor). To maintain the autonomy necessary to achieve a truly independent assessment of the Contractor's final status survey, the IVC has:

- Developed a Sampling and Analysis Plan (this document) that is separate and independent from the Contractor's Closeout Radiological Survey Plan,
- Specified instrumentation which is operated, calibrated, and maintained independent of all procedures, programs, or subcontractors employed by the Contractor,
- Selected an independent analytical laboratory (The DOE Grand Junction Office (GJO) Analytical Laboratory, operated by Wastren, Inc.) to perform radio-assays of sample media collected through implementation of this SAP, and
- Established a direct reporting relationship to the DOE–RFFO.

In spite of the autonomous nature of the IVC and the programs, plans, and procedures employed to independently verify the Contractor's final status surveys, the IVC will work closely with the Contractor to ensure that the DOE's interests are considered and the most cost effective, yet credible, independent verification is rendered.

DOE intends to use information developed and collected through implementation of this SAP to provide independent verification of the Contractor's sampling and survey results. This will be done by comparing measured Building contamination levels with the DCGLs specified in the *Closeout Radiological Survey Plan for the 779 Cluster* (RMRS 1998c) and by comparing sampling and survey results with those obtained by the Contractor.

Development of this SAP relied principally on the *Multi-Agency Radiation Survey and Site Investigation Manual* (MARSSIM) and incorporates conventional guidance from the U.S. Environmental Protection Agency (EPA). Principal guidance documents included:

- *Multi-Agency Radiation Survey and Site Investigation Manual* (MARSSIM) (EPA 1997)
- *Data Quality Objectives Process for Superfund* (EPA 1993)

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- *Guidance for Data Usability in Risk Assessment (Part A)* (EPA 1992)
- *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA* (EPA 1988)

A common theme in these guidance sources is using a seven-step data quality objectives (DQO) activity as the foundation for SAP development. Following this brief introduction will be a discussion of the building histories in Section 2 and a summary of the existing data in Section 3. The seven-step DQO process is described in Section 4. Section 5 discusses the sampling strategy and Section 6 details measurement techniques, and data quality issues. Section 7 discusses the equipment and tools used to implement the SAP. Appendices are included to provide Field Operating Procedures and additional detail where appropriate.

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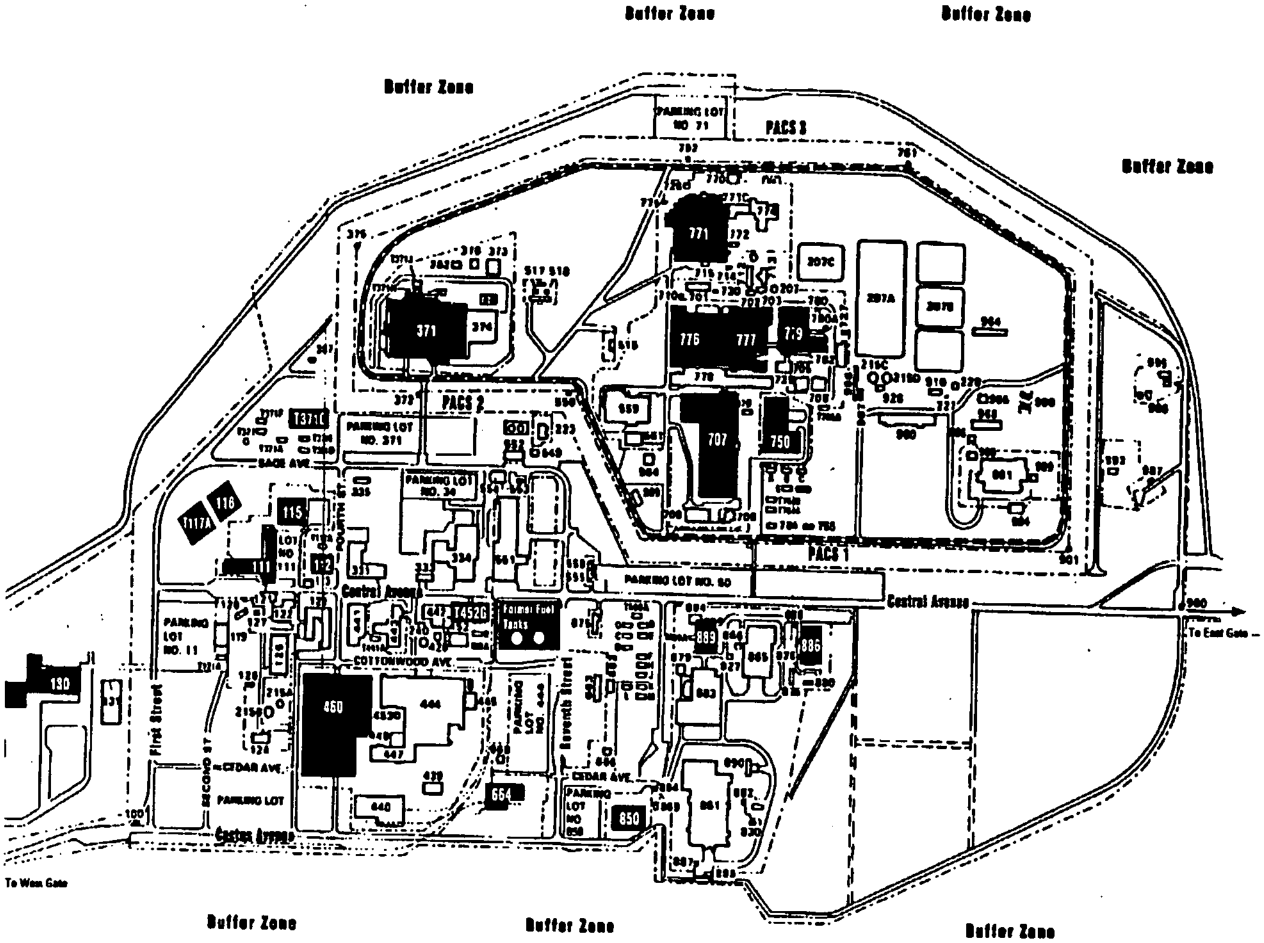

Figure 1–1. Site Map

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2.0 Building 779 Cluster Site History

The Building 779 Cluster is located on the DOE's Rocky Flats site near Golden, Colorado. The site is a former nuclear weapons production facility. The various process facilities and laboratories were grouped together with their various support buildings and structures and identified as "clusters," with the building number of the principal building as the cluster name (e.g., the Building 779 Cluster, Figure 2–1). The Building 779 Cluster was primarily used for research and development activities and supported a number of various operations as part of the research and development mission including: 1) Process Chemistry Technology, 2) Physical Metallurgy, 3) Machining and Gauging, 4) Joining Technology, and 5) Hydriding Operations. No processes or operations are now active.

2.1 Building 779

Building 779 was originally constructed in 1965 and has since been used as a nuclear weapons research and development facility. The building was expanded in 1968 and again in 1973. The additions (or annexes) are commonly called Buildings 779–A and 779–B, respectively. Although both additions are architecturally and structurally different from the original building, since they are physically connected to the original building and share resources and mission, this SAP uses the term Building 779 to mean the original building including the two additions.

The first addition to Building 779 (Annex A) was completed in 1968. This addition added office space, laboratory area dedicated to pyrochemical technology, hydride operations, physical metallography, and joining technology, as well as the necessary heating, ventilation, and air conditioning (HVAC) equipment necessary to supplement the existing systems. Annex A is a single story facility attached to the north end of the original building.

The second addition to Building 779 (Annex B) was completed in 1973. This addition is a two-story facility attached to the south end of the original building.

Building 779 contained nuclear material processing equipment and laboratory equipment to conduct materials and environmental testing until 1998 when operations were suspended and the building entered the decontamination and decommissioning (D&D) phase.

2.2 Building 779 Support Facilities

2.2.1 Building 729 Air Handling Building for Annex B, Building 779

Building 729 is an air filter plenum building built in 1971 which services the ventilation requirements of a portion of Building 779. The building is connected to Building 779 via a second story bridge carrying ventilation ducting and supports the Annex B addition to Building 779. It contained a filter plenum, associated air handling equipment, and an emergency diesel-powered electrical generator. The 2,750 square foot (ft^2) building (excluding the bridge) is constructed of concrete block.

2.2.2 Building 782

Building 782 was constructed in 1973 and served as the second filter plenum building for Building 779. The floor is constructed of reinforced concrete. The walls and roof are made of precast, reinforced concrete panels joined together. The roof is overlain with a 2-inch thick (minimum) composite, cast-in-place stone aggregate topping. There is an underground duct tunnel to Building 779, but this tunnel is not included in the scope of the Contractor's Closeout Radiological Survey Plan or the IV SAP. The 782 filter plenum building covers 5,950 ft^2 and is located east of Building 779.

2.2.3 Buildings 783, 727, 780, 780A, 780B

These buildings are small secondary support buildings for the Building 779 Cluster. They are not expected to be radiologically contaminated and will be considered together in the final status survey and in the IVC's independent verification surveys.

2.2.3.1 Building 783 Cooling Tower Pump House

2.2.3.2 Building 727

Building 727 is a small, 385 ft^2 building that houses a 500 kilowatt emergency diesel electric generator for the air handling system in Building 782. The single-story structure was built in 1973. The building has poured concrete foundation stem walls, and a poured reinforced concrete slab floor. Eight-inch concrete block walls support the 5-inch thick reinforced concrete roof slab which is covered by an asphalt-gravel roofing material. No radioactive material has been introduced or used in this building.

2.2.3.3 Buildings 780, 780A, and 780B

These are each small storage buildings built on concrete slabs. Building 780 has been used for paint storage. Building 780A was used for metal storage, and building 780B was used to store compressed gas bottles. No radioactive material has been introduced or used in these buildings.

2.2.3.4 Buildings 784, 785, 786, and 787

These cooling tower buildings are excluded from the scope of the Contractor's Closeout Radiological Survey Plan and from the IVC's independent verification surveys.

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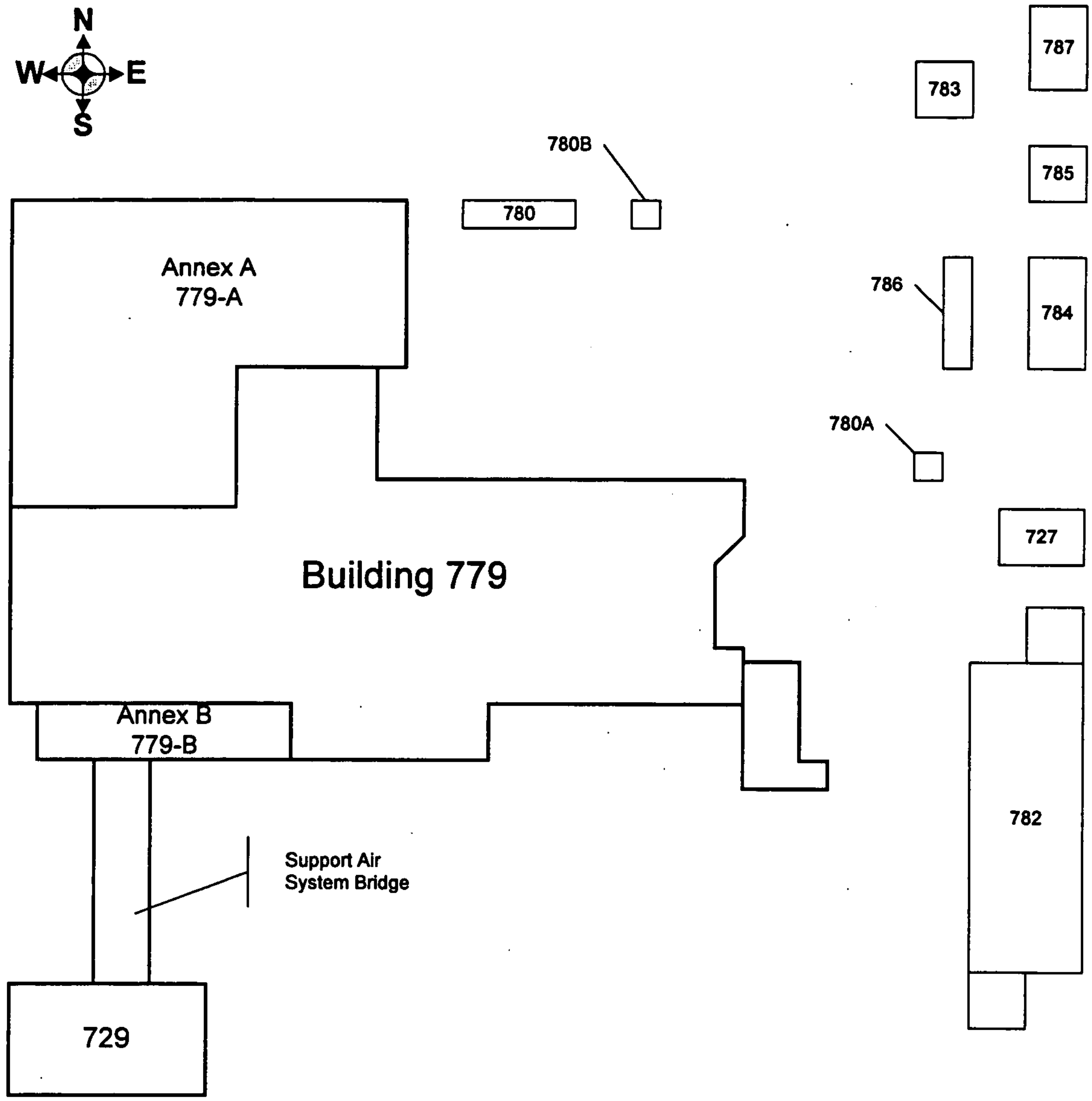

Figure 2–1. Building 779 Cluster Layout

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3.0 Preliminary Data

Preliminary data has been collected by the Contractor in support of the decontamination and decommissioning of the Building 779 Cluster. This preliminary data is important because it is used to:

- Help decide whether any area or building is classified as impacted or non-impacted.
- Help determine the class of impacted survey units.
- Establish the survey unit boundaries.
- Identify the contaminants that are expected to be present in each survey unit.
- Determine the analytical methods needed to detect and quantify the contaminants present.
- Estimate the minimum sample size needed to achieve sufficient statistical power to either accept or reject the null hypothesis within the bounds of the accepted decision errors.
- Exclude the need for beta contamination measurements as part of the final status survey.

Since this sampling plan is the IVC's SAP in support of the effort to independently verify the final status survey performed by the Contractor, a quantitative assessment of the concentrations of radiological contaminants is not pertinent to the development of the sampling strategy for this SAP. Prior to the implementation of this SAP, the Contractor will have completed the decontamination of all areas identified having surface contamination in excess of the applicable DCGL, effectively altering the concentrations of contaminants and their distribution. The mean concentration in each of the survey units then is expected to be below the applicable DCGL.

3.1 Preliminary Data Affect on Minimum Sample Size

There is apparently little quantitative data to suggest the appropriate value for the expected distribution of data about the mean concentration. The factor used to express the distribution of data about the mean is the coefficient of variation (CV). An *a priori* estimate of the CV is used to determine the minimum sample size needed to achieve statistically significant results from the collected data. The net effect of selecting an estimate of CV lower than the true or measured CV is a possible lack of statistical power necessary to substantiate that the survey unit meets the DCGL due to obtaining too few samples or measurements. The assumption of CV for sample planning purposes, then, does not impact the decision rule. Rather, a low estimate of CV will result in too few samples collected to be able to reject the null hypothesis (H_O). On the other hand, a high estimate of CV will result in the collection of excessive samples or measurements and associated higher implementation costs. The IVC estimates that the CV could be as high as 0.5 and has used this estimate to calculate minimum sample size.

The estimate of the CV is not the only parameter that might impact the determination of the minimum sample size. The decision rule will be applied independently to each survey unit rather than to a building as a whole. Preliminary data collection does not provide enough detail to substantiate an assumption about the shape of the distribution of data. Additionally, the distribution of data may be altered as a result of decontamination efforts effected by the Contractor. Consequently, a minimum number of samples or measurements per survey unit should be collected to allow data reduction methods to reasonably establish the underlying distribution(s) so that appropriate statistical treatment of the data is applied. An additional concern affecting sample size is achieving representative coverage of the survey unit.

3.2 RFETS Contractor Supplied Preliminary Data

Based on the review of historical records, process knowledge of the identified project buildings and associated equipment/systems, and the result of radiological surveys, the Contractor has identified the radiological contamination potential for the Building 779 Cluster as follows (RMRS 1998c):

- Significant levels of plutonium contamination existed in the majority of the glove boxes, hoods, and ventilation systems in Building 779.
- To a lesser extent, uranium and americium contamination existed in the majority of the glove boxes, hoods, and ventilation systems in Building 779.
- Alpha contamination on floor and wall surfaces in many rooms has been fixed with paint.
- A significant number of spills of transuranic material have occurred in many of the laboratory areas.
- The potential exists for contamination to be in floor cracks as well as beneath the asbestos floor tiles.
- Numerous incidents of high airborne alpha activity have potentially contaminated many surface areas of Building 779.
- Portions of the filter plenums in Buildings 729 and 782 contain significant levels of alpha contamination. The heat chamber and first stage of Plenum 408 were designated "High Contamination Areas" (greater than 100 times the DCGL).
- The Contractor has completed a review of the RFETS source registry and interviewed building personnel with long-term historical information to determine the type of radioactive material maintained in the 779 cluster buildings throughout their lifetime. Based on the review of the source registry and process knowledge provided, the Contractor concluded that the only DOE radioactive material used, processed, or maintained in the 779 cluster buildings (other than instrument check sources, such as Co-57, Co-60, Cs-137, Fe-55, Sr-90, and gaseous H-3 sources) was americium, plutonium, and uranium.
- There have been no recorded instances of radioactive check source leaks.
- Process knowledge obtained from Waste Stream and Residue Identification and Characterization (WSRIC) documentation indicates that the process use of radionuclides in Building 779 has been limited to plutonium, americium, and uranium.
- Plutonium, americium, and uranium have been identified as the only nuclides resulting from DOE operations present in the Building 779 Cluster. Buildings 779, 782, and 729 contain Radiological Buffer Areas, Contamination Areas, and High Contamination Areas that contain isotopes of americium, plutonium, and uranium.

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- The principal material handled and processed in Building 779 was Weapons Grade Plutonium (WGP). Analysis was performed by Sandia National Laboratories (RMRS 1998c) to characterize the composition of WGP. This characterization showed that WGP can be assumed to contain the following primary isotopes of concern and associated weight fractions:

Primary Isotopes	Weight Fractions %	Specific Activity TBq/g	Activity Fraction %
Pu-238	0.03	6.34E-1	1.33
Pu-239	93.9	2.30E-3	15.12
Pu-240	5.7	8.43E-3	3.36
Pu-241	0.3	3.81E00	80.01
Am-241	0.02	1.27E-1	0.18
Summation	99.95		100

Plutonium-239 and Pu-241 clearly dominate the radioactivity associated with WGP. Pu-241 undergoes radioactive decay by beta emission. The maximum energy of the beta particle is 20.81 keV and the average energy is 5.23 keV. A 20 keV beta particle has a range of approximately 0.7 milligrams per square centimeter (mg/cm^2). In addition, Pu-241 beta particles are difficult to detect using conventional survey instrumentation and contribute negligibly to the radiobiological consequences of human contact with WGP.

Pu-238, Pu-239, Pu-240, and Am-241 decay by alpha emission. Am-241 is a daughter product of Pu-241 and emits a characteristic 60 keV photon during decay. In-growth of Am-241 is fairly rapid due to the short half-life of Pu-241 (13.8 years). The specific activity (Curies/gm) of WGP is driven by the mass of Pu-239 and Pu-240. Combined, they account for approximately 87 percent of the alpha activity. The remainder of alpha activity is due to the decay of Am-241 and Pu-238.

Other materials handled and processed in Building 779 were highly enriched uranyl nitrate (HEUN) and depleted uranium (DU).

HEUN contains U-234 and U-235 which both decay by alpha emission. The specific activity varies with the percent enrichment. HEUN enriched to 90 percent U-235 has an alpha to beta ratio of approximately 100 to 1. U-235 also emits a characteristic 185 keV gamma following decay.

DU is uranium which has been processed to remove U-235 (approximately 0.2 percent U-235 by weight remains with the DU). DU consists of U-238 and its daughter products. U-238 decays by alpha emission and has two daughter products in secular equilibrium: Th-234 and Pa-234m. Th-234 and Pa-234m both decay by beta emission. The secular equilibrium status means that there are two betas given off for every one alpha from U-238. Approximately 90 percent of the alpha emissions are from U-238 and approximately 8.4 percent from U-234. The beta to alpha ratio is approximately 1.8 to 1.

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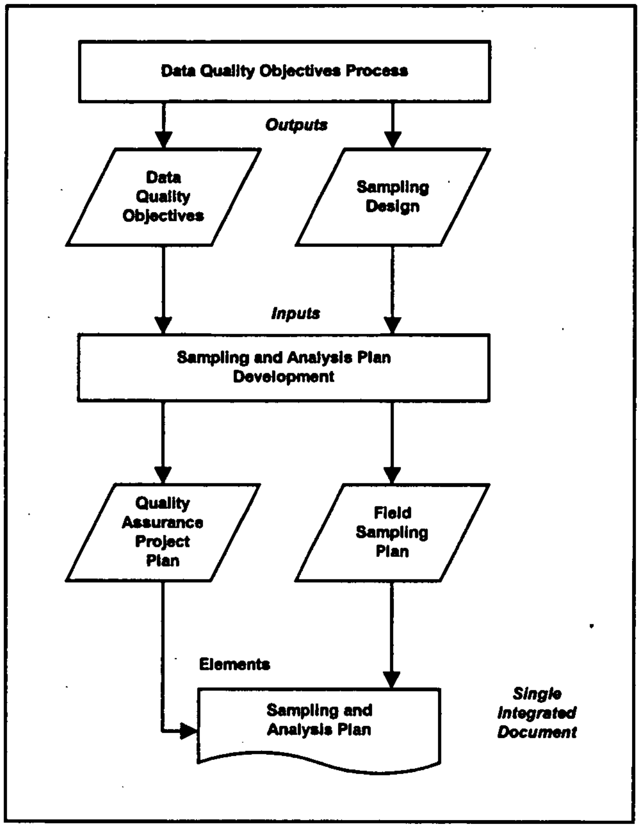
4.0 Data Quality Objectives

The DQO activity is a series of planning steps based on the Scientific Method that is designed to ensure that the type, quantity, and quality of environmental data used in decision making are appropriate for the intended application (EPA 1993). As indicated in Figure 4–1, completing the DQO evaluation activity is one of several components of planning for the data collection process.



Source: EPA 1993

Figure 4–1. Planning for Data Collection

The IVC has developed a Quality Assurance Program Plan (QAPP) for its Independent Verification Program (IVP). The Contractor's IVP is broad based and multi-faceted. As a result, the IVP QAPP, too, is broad based and overarching all of the IVC's independent verification projects. As this SAP was developed, the criteria and requirements of the QAPP were incorporated where applicable. In addition, the Independent Verification of the Building 779 Cluster Final Status Survey Project requires the consideration of project-specific quality assurance measures. Figure 4–1 identifies this element as the Quality Assurance Project Plan (QAPjP). While there is no discrete QAPjP document for this project, the elements of the QAPjP are developed and integrated along with the field sampling plans and procedures into this SAP. This SAP, including all appendices, is the single integrated document referenced in Figure 4–1.

The project-specific DQO's are presented in Table 4–1 in the seven-step format prescribed (EPA 1993).

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Table 4–1. Data Objectives and Specification Summary

DQO Element		Response
1	Problem Statement	The 779 Cluster Buildings are potentially contaminated with radioactive residue from their use as a nuclear weapons research facility. A key feature of the overall decontamination and decommissioning quality assurance program specifies that final status surveys be independently verified. DOE needs an independent assessment verifying or refuting the Contractor's conclusions regarding the disposition of the buildings in the 779 Cluster. In part, this requires that an independent party determine the magnitude of the residual radioactive contamination.
2	Decisions to Be Made	• Is the level of residual radioactivity in the survey unit(s) selected for independent measurement and sampling below the release criterion? • Does the conclusion reached by the IVC regarding a specific survey unit selected for independent verification agree with the Contractor's conclusion for the same survey unit?
3	Decision Inputs	Specific decision input information: • An estimate of the average (median) removable surface contamination concentration in the selected survey unit(s). • An estimate of the average (median) total surface contamination concentration as measured by direct surface emission in the selected survey unit(s). • An estimate of the maximum total surface contamination concentration as measured by direct surface emission in the selected survey unit(s). • An estimate of the average (median) transuranic contamination concentration on and beneath a surface with a surface coating as measured by collection and analysis of a surface media sample in the selected survey unit(s). • An estimate of the average (median) uranium contamination concentration on and beneath a surface with a surface coating as measured by collection and analysis of a surface media sample in the selected survey unit(s). • The Contractor's reduced data set and conclusion(s) for the selected survey unit(s). These decision inputs will be obtained directly from the independent verification survey and the Contractor's final status survey results.
4	Study Boundaries	The study encompasses the interior and exterior surfaces of the affected or impacted buildings within the Building 779 Cluster. The study does not include: • Below grade foundations (which will be addressed separately) • Building 779 Cluster Cooling Towers and Chillers (Buildings 784, 785, 786, and 787). • Non-fixture and non-structural materials in the Buildings (e.g., portable equipment, tools, furnishings, shelves). These items are not considered part of the building and will be released by RFETS Contractor personnel as items and materials in accordance with local procedures. • Areas designated by the Contractor as unaffected (non-impacted). Each survey unit selected for independent verification will be treated distinctly (as independent survey units).

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DQO Element		Response
5	Decision Rule	IF the independent verification survey concludes that: • the mean (median) removable α surface contamination concentration in the selected survey unit(s) is below 20 dpm/100 cm^2, AND • the mean (median) total α surface contamination concentration as measured by direct surface emission in the selected survey unit(s) is below 100 dpm/100 cm^2, AND • the maximum total α surface contamination concentration as measured by direct surface emission in the selected survey unit(s) is below 300 dpm/100 cm^2, • the mean (median) transuranic contamination concentration on and beneath a surface with a surface coating as measured by collection and analysis of a surface media sample in the selected survey unit(s) is below 100 dpm/100 cm^2, AND • the mean (median) uranium contamination concentration on and beneath a surface with a surface coating as measured by collection and analysis of a surface media sample in the selected survey unit(s) is below 1000 dpm/100 cm^2 THEN conclude that the survey unit meets the release criterion. IF the IVC survey conclusion disagrees with the Contractor's final status survey conclusion, THEN refute the Contractor's conclusion for the survey unit and consult with the DOE–RFFO contact for direction on discrepancy resolution.
6	Decision Uncertainties	The following quantitative factors will be integrated into the data collection plan: • True state of nature, H_o, (null hypothesis) = the mean (median) removable α surface contamination concentration in the selected survey unit(s) is greater than 20 dpm/100 cm^2, AND the mean (median) total α surface contamination concentration as measured by direct surface emission in the selected survey unit(s) is greater than 100 dpm/100 cm^2, AND the maximum total surface α contamination concentration as measured by direct surface emission in the selected survey unit(s) is greater than 300 dpm/100 cm^2, AND the mean (median) transuranic contamination concentration on and beneath a surface with a surface coating as measured by collection and analysis of a surface media sample in the selected survey unit(s) is greater than 100 dpm/100 cm^2, AND the mean (median) uranium contamination concentration on and beneath a surface with a surface coating as measured by collection and analysis of a surface media sample in the selected survey unit(s) is greater than 1000 dpm/100 cm^2 • Gray Region ➢ mean removable α surface contamination = 10 to 20 dpm/100 cm^2 ➢ mean total α surface contamination = 50 to 100 dpm/100 cm^2 ➢ mean TRU subsurface contamination = 50 to 100 dpm/100 cm^2 ➢ mean uranium subsurface contamination = 500 to 1000 dpm/100 cm^2 • False positive (Type I) error rate = 0.05 • False negative (Type II) error rate = 0.05 • Coefficient of variation (CV) = 50 percent • Sample size margin = 20 percent

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DQO Element		Response
7	Design Optimization	To provide independent verification of the Contractor's sampling results, it is not necessary to survey or sample with the same density as specified in the Contractor's Closeout Radiological Survey Plan. Rather, the independent verification sampling program will focus on a fraction of the survey units identified in each building. These will be surveyed with a sample density sufficient to achieve satisfactory statistical power to verify or refute the Contractor's results for a given survey unit. In this way, the IVC SAP serves as a quality assurance measure used to validate the Contractor's process and assumptions for an entire building (or group of buildings) and the results and conclusions for a specific survey unit verified. This design will be used to optimize data collection.

Notes:

1. Development of sample sizes is detailed in Section 5.3.
2. It is recognized that a failure to adequately assess decision errors could result in low power. However, the data quality analysis (DQA) process will assess the actual power considering the magnitude of the mean and CV versus the DCGL for the sample density actually collected. Since the null hypothesis presumes the survey unit to exceed the DCGL, a lack of statistical power will result in a greater probability of false positive errors and a more conservative rather than less conservative decision basis. If retrospective power computations reveal unacceptable confidence, the DOE will determine if additional sampling is warranted in order to attempt to release the survey unit in question.
3. While the DCGL has been expressed as the average or mean concentration (RMRS 1998c), a skewed distribution (such as is expected for measuring environmental levels of radionuclide activity) or the use of a single sample, non-parametric, statistical test (such as the Sign Test) indicate the use of median as the appropriate metric for comparison to the DCGL.

Key points summarized from Table 4–1 include:

1. The 779 Cluster buildings potentially contain residual radiological contamination stemming from their former use as a nuclear weapons research facility. The question confronting the decision maker and risk manager (DOE–RFFO) is:

   Does the independent assessment of the residual radioactive contamination verify or refute the conclusion reached by the Contractor after their performance of the final status survey?

2. The decision must consider the concentration of residual contamination present in the Buildings.

3. Inputs required to make decisions involve developing estimates of the average (median) removable, average (median) total as measured by direct surface emission, average (median) total as measured by collection and analysis of surface media samples, and maximum total surface contaminant concentration as measured by direct surface emission in survey units identified by the Contractor and selected for verification sampling by the IVC.

4. There are two possible decision rules to consider:

- If the IVC concludes that the residual radioactive contamination is below the applicable DCGLs, then conclude that the survey unit meets the release criterion.
- If the IVC's conclusion for the selected survey unit(s) disagrees with the Contractor's conclusion following final status survey, then the IVC will refute the Contractor's conclusion.

5. The uncertainties associated with the decision will be addressed to provide reasonable assurance that a conservative decision is made. The quantitative factors used to develop the

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IVC sampling plan will ensure that, at the 95 percent upper confidence level (UCL_{95}), decision makers will not incorrectly conclude that the DCGL is not exceeded if in fact the DCGL is exceeded.

6. The sampling design will be optimized to obtain adequate statistical power to directly assess the Contractor's conclusion regarding a selected survey unit. This design avoids excessive surveying and sampling each survey unit identified by the Contractor, or spreading verification sampling out over each survey unit such that inadequate sampling density might preclude having sufficient statistical power to either verify or refute the Contractor's conclusion in a given survey unit.

An important step in the DQO process not explicitly identified in Table 4–1 is identification of the decision makers and incorporation of their input. For this independent verification project the decision maker is the DOE–RFFO.

Representatives from DOE, EPA Region VIII, and State of Colorado Department of Public Health and Environment have participated in working meetings and have reviewed and approved the Contractor's SAP. This IV SAP incorporates the decision maker's and regulators' objectives as expressed in the contractor's approved *Closeout Radiological Survey Plan for the 779 Cluster* (RMRS 1998c).

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5.0 Sampling Survey Design

5.1 Overall Survey Design

The Decision Rule requires comparing the mean (median)[a] removable surface contamination concentration, the mean (median) total α surface contamination concentration, and the maximum total α surface contamination concentration in the selected survey unit(s) to their respective DCGLs. The mean (median) surface contamination concentrations are considered the representative activity concentrations for the survey unit(s). Thus, a design yielding arithmetic or log-normal means (medians) as well as the maximum total surface contamination concentration is required. It is desirable to collect a sufficient number of samples so that the mean (median) will not be particularly sensitive to variation as a result of even spurious or anomalous results. It will also be useful (although not directly or statistically important to the application of the Decision Rule) to obtain distribution and summary parameters (e.g., variance, percentile estimates, upper confidence level estimates, etc.) to provide risk managers additional information.

The plan must accommodate and address the need for spatial distribution and unbiased random selection of discrete sampling locations. The sampling design will furnish spatial distribution so that the data it provides can be considered *representative* of the survey unit selected for independent verification and, therefore, extended to the entire survey unit being considered. To permit unbiased assessment of the mean, median, and other summary parameters, the selection of sampling locations must be unbiased, and the sampling program should be based, in large part, on a random selection of points.

The use of wholly independent laboratories and service providers is essential to the autonomy required to provide an unbiased and independent verification of the Contractor's survey results. To meet this objective, the IVC will select laboratories and service vendors (where there is a potential conflict that might suggest a lack of independence) other than those used by the Contractor in the performance of their final status survey. The IVC has selected the GJO Analytical Laboratory to perform the laboratory assays required.

In addition to the measurements made and samples collected to independently verify the Contractor's sampling results and conclusions for a given survey unit, the IVC is responsible for the independent assessment of the process and methods used by the Contractor during the final status survey and of the results of the data collected in survey units not independently measured by the IVC. In large part, this is accomplished by reviews of: 1) implementing documents, 2) field observation of the performance of the final status survey, and 3) a review of survey results. However, in addition to these passive verification methods, the IVC may collect split or duplicate media samples as an independent quality control (QC) measure of the sampling and analytical process. Independent QC sampling design is addressed in Section 5.1.1 below.

[a] The DCGL has been expressed as the average or mean concentration (RMRS 1998c). However, a skewed distribution (such as that expected when measuring environmental levels of radioactivity) or the use of a single sample, non-parametric, statistical test (such as the Sign Test) indicate the use of median as the appropriate metric for comparison to the DCGL. Both the mean and median will be available from the design of the sampling plan.

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The spatial distribution and unbiased random selection objectives will be realized through a hybrid approach combining random and spatial aspects. The sample location selection approach is discussed below.

5.1.1 Stage I—Independent Quality Control Sampling

As the Contractor implements their Closeout Radiological Survey Plan, they will, in certain prescribed situations, collect smears to determine the removable radiological surface contamination concentration and media samples to determine the radiological contaminant concentration beneath (and incorporated within) the exposed surface being surveyed. Media samples collected from a building surface may include layers of paint, surface veneer layers of concrete or cinder block, gypsum wall board, or even roofing material residue.

The IVC will coordinate with, and may observe, the Contractor during their collection of smear and media samples. As the Contractor collects sample media, the IVC may collect split or duplicate samples with the Contractor. The IVC may also provide blanks and blind spikes to the Contractor for analysis. In each case, the portion of the split, duplicate, or spiked sample retained by the IVC will be analyzed by a qualified laboratory independent from the laboratory used by the Contractor.

These independent QC samples do not necessarily have to originate from one of the buildings being considered for release under the D&D program for the Building 779 Cluster. Nor do they have to be associated with any specific survey unit or building within the cluster. These samples are designed to assess the overall quality of the Contractor's media sampling and analytical processes through comparative statistical analysis. They do not contribute to the population of samples and measurements used to assess the radiological surface contamination levels of a specific survey unit to the DCGLs.

5.1.2 Stage II—Independent Verification of Selected Survey Units

This sampling stage will entail independent verification of the Contractor's conclusions for selected survey units. Stage II sampling will develop a representative characterization of the residual radioactive contamination on the building surfaces in each survey unit selected for independent verification. This will be done in each building (or group of buildings) within the Building 779 Cluster, which is subject to the D&D project's final status survey. Representative characterization will be accomplished by using a random-start, systematic grid approach to ensure spatial representation of the survey unit of interest.

The survey unit will be divided into a grid of proportionally equal sampling frames. The systematic sampling sequence will be initiated from a randomly selected grid intersect location within the survey unit. Thus, beginning at a randomly selected location within the sampling frame, samples will be taken from every "nth" intersect point within the sampling frame resulting in a systematic array of samples producing equa-proportional spatial coverage. This approach ensures an unbiased sample selection, spatial representation, and direct correlation to the Contractor's closeout radiological survey results for the survey unit being sampled. The survey unit sampling results (e.g., mean, median, standard deviation, UCL_{95} of the mean or median) from the representative areas measured or sampled are easily extended, conceptually, to unsampled portions through the assumption of unbiased representativeness.

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Stage II results will be used to compute the applicable contaminant concentrations for comparison to the DCGLs, and for comparison with the Contractor's computations of the same parameters using their final status survey data.

DOE will independently verify at least one survey unit (Stage II Sampling) from each building (or group of support buildings) being considered for release and up to 10 percent of the survey units in Building 779. The selection of survey units for independent verification will be based on random selection with assignment of higher priority to survey units, which have a greater potential to have contamination in excess of the DCGLs as well as professional judgement. In this way, at least one survey unit of each "impacted" or affected classification (i.e., Class 1, 2, or 3) from among all those identified in the Building 779 Cluster (RMRS 1998a) will be surveyed. In a given building, however, more weight will be given to the selection of survey units classified as "Impacted Class 1" for independent verification.

5.2 Data Analysis Framework

The data analysis framework is critical to sample plan development because it establishes the basis for decision and drives the sample size. The independent verification process will use an analysis structure incorporating three possible common statistical procedures as well as conventional qualitative and semi-quantitative comparisons. The tests are:

- **Sign Test**—The Sign Test is a one-sample, non-parametric test that can be used to evaluate compliance with the DCGL. The Sign Test is the recommended compliance evaluation procedure when the contaminant(s) under evaluation are not present at significant levels in background. The Contractor has stated that the "...contaminants of concern are not present to an appreciable extent in the background for the Building 779 Cluster." Any one of the individual samples (each individual survey unit is a "sample" in this context) or any combination can be compared to the DCGL with the Sign Test. (e.g., each of the Class 1 survey units could be pooled for an overall building comparison to the DCGLs rather than comparing an individual survey unit to the DCGL).

- **Wilcoxon Rank Sum Test**—The Wilcoxon Rank Sum (WRS) test is a two-sample, non-parametric procedure that can be used to evaluate compliance when the contaminant is present in background. In this case, however, since the contaminants of concern are not expected to be present in background, the WRS test can be used as a two-sample test to compare means between samples (e.g., contamination concentration measured by the Contractor's analytical laboratory vs. the same parameter measured by the IVC's laboratory) when either or both sampling distributions deviate significantly from normal.

- **Normal Means Test**—This is the traditional two-sample t-test based on the central limit theorem (i.e., normality). It can be used to assess compliance, derive confidence intervals, and compare between samples (e.g., mean removable surface contamination concentration in one survey unit vs. the same parameter measured in another survey unit) when both sample distributions are normal or do not deviate appreciably from normality.

The Sign Test will be used to evaluate compliance with the mean (median) removable and total surface contamination DCGLs. Analysis of variance using the WRS or Normal Means test, as appropriate, will be used to compare means (medians) between independent QC sample groups (e.g., Contractor smears vs. IVC measurement of the same subset of smears). In addition to these

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inferential tests, data analysis will include qualitative visual analysis (e.g., histograms, scatter diagrams, box and whisker plots). Additional analytical methods (e.g., spatial correlation) as well as spatial analysis (e.g., posting on diagrams, iso-concentration plots) not required to support the decision rule are not explicitly planned for but could be employed on an ad-hoc basis to gain insight.

The data analysis framework will incorporate data quality analysis (DQA) components discussed in MARSSIM (EPA 1997) and EPA Guidance (EPA 1992) to assess the overall usability of the data for its intended use. The data will be validated, and statistical analysis methods will be used, to assess whether variability and bias in the data are small enough to allow DOE to use the data to support the sampling objective—independent verification of the final status survey results and conclusions—with acceptable confidence. Risk managers will be presented with an ensemble of information, logically interpreted, and supported by rationale to gauge compliance. The data collected through implementation of this SAP is neither intended, nor designed, to produce any single metric (i.e., one test) which will necessarily dictate the findings. In fact, the data collected via this SAP is, in itself, insufficient to support the overall risk management decision objective for the D&D of the buildings in the Building 779 Cluster. Rather, the IV SAP serves as a quality assurance measure providing the decision maker with a compliance gauge. Indeed, additional comparative analyses using both Contractor and IVC collected data sets may be indicated and employed to provide additional information by which the decision makers may gauge compliance.

5.3 Sample Sizes

5.3.1 Stage I—Independent Quality Control Sample Size

Independent QC samples are collected to assess the potential variability between the sample collection and analytical processes employed by the Contractor and IVC. As such, they are not related to the minimum sample size calculations addressed in MARSSIM. To assess this potential variability and its impact on the conclusions reached by the Contractor following implementation of the final status survey and on the conclusions reached by the IVC through implementation of Stage II sampling called out in this plan, analysis of variance will be used on selected subsets of samples collected and/or analyzed by both the Contractor and the IVC. Independent QC samples are not related or tied to survey units and, therefore, may be collected at any time and from any survey unit, building, or combination of these throughout the Building 779 Cluster. The question to be analyzed is: Is there a statistically significant difference between the results of independent QC samples reported by the Contractor and those reported by the IVC. There are three basic measures of the residual radiological surface contamination to be made.

- Total surface contamination as measured directly on the surface (*in situ*),
- Total surface contamination as measured by removing and collecting the surface (and associated subsurface layer(s)) suspected to be contaminated, and
- Removable (loose) surface radiological contamination as measured by wiping with smears.

Fundamentally, there are five types of QC samples that may be employed—duplicates, splits, replicate measurements, blanks, and spikes. Because there can be no assurance in the field that contaminant distribution in an area selected to collect media samples is uniform, duplicate samples are not suitable as QC samples in this independent verification sampling scheme. The

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other sample types have some application to the sampling scheme, but not all are appropriate for each of the three basic measures being verified.

The independent QC sample size and type for each of the three basic measures are itemized in the following sections.

5.3.1.1 Total Surface Contamination by Direct Measurement

The Contractor has selected a proprietary measurement system operated by Millenium Services, Inc. and Shonka Research Associates, Inc. to perform the bulk of the direct measurements to be made in the final status surveys. This system is a data-logging, scanning (or frisking) system which cannot be readily field replicated with available static or scanning measurement technology. No discreet media samples are collected in the process of this measurement type; consequently, no splits or duplicates can be obtained. It is not considered reasonable or necessary to attempt to collect replicate measurements since different direct measurement procedures and instruments are scheduled to be used to effect the overall survey plan. Instead, the IVC will review and verify the calibration procedure, which standardizes an instrument to a known quantity National Institute of Standards and Technology (NIST) traceable source of radioactivity. Blank and spike samples are not applicable for direct scanning measurements of this type.

It is possible to make comparison measurements (replicate[a]) between the Contractor's direct measurement instrumentation, their subcontractor's proprietary measurement system, and the direct measurement instrument used by the IVC. In essence, this measurement amounts to a source response check of each measurement system using a common radioactive check source. The test serves a comparison benchmark rather than a measure of accuracy of one system over the next. Table 5–1 specifies the Stage I QC sample schedule for intercomparison measurements of the three direct measurement systems scheduled to be used.

Table 5–1. Independent Quality Control Sample Schedule–Direct Measurements

Quality Control Sample Type	Number Specified
Comparison Measurements (Replicates)	5

5.3.1.2 Total Surface Contamination by Surface Media Analysis

Sample media collected using this measurement type will be sent to selected laboratories for analysis. Because the media collected result in significant self-shielding, the laboratories are expected to consume or destroy part or all of the sample in the analytical process. Replicate measurements are, therefore, not possible for this set.

Field duplicates are also not possible since there is no assurance that an independent verification sample collected directly adjacent to one collected by the Contractor will have the same contamination concentration.

[a] The comparison measurements specified are not replicates in the true sense of the meaning, but are in effect replicate measurements of the same activity since they use a common radioactive check source. Rather than measuring the precision of a single measurement method, however, it measures the relative precision between different measurement systems. Substantial disparity (lowest reading instrument <20 percent of the highest reading instrument) between measurement system responses to the same radioactive source would require resolution.

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Field splits are possible, provided there is some reasonable means of homogenizing the sample media collected and then splitting the sample into two; one for the Contractor and one for the IVC. There is one expected technical difficulty associated with field split samples. It is entirely possible that the majority of samples collected, if randomly selected, will have residual activity below detection capability. If a significant portion of QC samples collected were below detection limits for one or both laboratories being compared, the data set would have little usefulness.

A more satisfactory method of comparing laboratories (but not sample collection processes) would be for the IVC to provide prepared and split homogeneous samples to be provided to the Contractor and the IVC laboratories during the final status survey process. These samples could be collected in areas within the Building 779 Cluster prior to decontamination efforts with knowledge that they do contain concentrations of the contaminants of concern above the DCGL or spiked with contaminants of concern and then provided for analysis. Spiked samples are not easily constructed for the type and ranges of media sample compositions likely to be encountered and caution should be exercised in making inferences about laboratory quality based on analysis of spike samples alone. This will ensure that a sufficiently robust data set is collected with which to compare analytical processes without impacting the conduct of the final status or independent verification surveys.

It is also possible to collect media samples from areas known to be unaffected (non-impacted) to be submitted as blanks.

Table 5–2 identifies the Stage I, independent, QC samples specified for media samples in this IV SAP.

Table 5–2. Independent Quality Control Sample Schedule–Media Samples

Quality Control Sample Type	Number Specified
Duplicates	0
Replicates	0
Splits/Spikes	25
Blanks	5

5.3.1.3 Removable Surface Contamination Smear

Sample media collected using this measurement type will also be sent to selected laboratories or counting facilities for analysis.

Because the sampling method collects removable contaminants on a fixed-size sample media, split samples are not possible for this set.

Field duplicates are also not possible for the same reasons identified in Section 5.3.1.2 above.

Replicate measurements are possible for smear samples. Replicates provide the most reasonable measure of comparison between different measurement systems used by the Contractor and IVC. Again, there is a technical difficulty associated with the possibility that the majority of samples collected, if randomly selected, will have residual activity below detection capability.

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As with media samples above, a satisfactory method of comparing analytical methods (but not sample collection processes) would be for the IVC to provide prepared smear samples to the Contractor first and then to the IVC's laboratory (or *vice versa*) for replicate measurement during the final status survey process. These QC smear samples could be collected in areas within the Building 779 Cluster prior to decontamination efforts with knowledge that they do contain removable concentrations of the contaminants of concern above the DCGL. Spiked samples are also possible to prepare and provide to the Contractor and will be used for this measurement type. This will ensure that a sufficiently robust data set is collected with which to compare analytical processes without impacting the conduct of the final status or independent verification surveys.

It is also possible to provide smear samples from areas known to be unaffected (non-impacted) to be submitted as blanks.

Table 5–3 identifies the Stage I, independent, QC samples specified for smear samples in this IV SAP.

Table 5–3. Independent Quality Control Sample Schedule—Smear Samples

Quality Control Sample Type	Number Specified
Duplicates	0
Replicates/Spikes	30
Splits	0
Blanks	5

5.3.2 Stage II — Selected Independent Verification Survey Unit Sample Size

Minimum sample sizes computed using standard formulas for the three inferential tests are presented below. All sample size estimations assume:

- A standard deviation (σ) of 10 dpm/100 cm^2 for the sample set used to determine the mean (median) removable surface contaminant concentration (i.e., a 50 percent coefficient of variation[a] if the true mean is 20 dpm/100 cm^2).[b]

- A standard deviation of 50 dpm/100 cm^2 for the sample set used to determine the mean (median) total surface contaminant concentration (i.e., a 50 percent coefficient of variation if the true mean is 100 dpm/100 cm^2).

- A shift (Δ) of 10 dpm/100 cm^2 is determined to be significant for the removable surface contaminant concentration. A shift of 50 dpm/100 cm^2 is identified as significant for the total surface contaminant concentration (RMRS 1998c). The shift is the width of the gray area below and above which uncertainties in discrimination are critical to the decision maker. The shift defines the decision maker's critical window of observation and is based on the decision

[a] coefficient of variation = 100 × standard deviation/mean

[b] The Contractor's Closeout Radiological Survey Plan for the 779 Building Cluster assumes a 30 percent CV. Because the selected DCGLs are so low relative to detection limits, the IVC has chosen to use a slightly more conservative estimate of the sample population deviation and resulting CV. This decision results in a larger number of samples necessary to assess compliance, but is more likely to avoid the need to remobilize in order to collect additional samples due to insufficient statistical power.

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maker's acceptance of consequences of making Type I and Type II errors in testing the null hypothesis.

- The relative shift (Δ/σ) is the ratio of the shift and standard deviation. The calculated value of relative shift for both the removable and the total surface contaminant concentration is 1 (e.g., 10 dpm/100 cm^2 / 10 dpm/100 cm^2 =1.0).

- Null hypotheses (H_o) of:

  ➢**Mean (median) Removable α Surface Contamination Level ≥ 20 dpm/100 cm^2 Gross Alpha.**
  ➢**Mean (median) Total α Surface Contamination Level ≥ 100 dpm/100 cm^2 Gross Alpha.**

  This is the conservative form of the null hypothesis that places the highest burden of proof on DOE to demonstrate that the average contaminant concentration in the survey unit is less than the DCGL (EPA 1993).

- False positive err rate = 0.05 (i.e., alpha = 0.05). This ensures that there will be no greater than a 5 percent chance of incorrectly rejecting the null hypothesis and finding that a survey unit mean (median) surface contamination concentration is *less than* the DCGL when in fact it is greater than the DCGL.

- False negative err rate = 0.05 (i.e., beta = 0.05). This ensures that there will be no greater than a 5 percent chance of incorrectly accepting the null hypothesis and finding that a survey unit mean (median) surface contamination concentration *exceeds* the DCGL when in fact it is less than the DCGL.

Computed minimum sample size per survey unit is calculated assuming the sampling statistics itemized above and using the sample size calculations prescribed in MARSSIM (EPA 1997). The minimum sample size is tabulated in Table 5–4. The sensitivity of the minimum sample size computation to "relative shift"—the variable with the greatest impact on sample size—is illustrated in Figure 5-1. The computations are shown in the following equations.

The relative shift is determined for each of the measurements and samples to be performed. The relative shift for the removable and total radiological surface contamination are shown in Equations (1) and (2), respectively.

$$\Delta/\sigma = \frac{(\text{DCGL} - \text{LBGR})}{\sigma_s} = \frac{(20-10)}{10} = 1.0 \qquad (1)$$

$$\Delta/\sigma = \frac{(\text{DCGL} - \text{LBGR})}{\sigma_s} = \frac{(100-50)}{50} = 1.0 \qquad (2)$$

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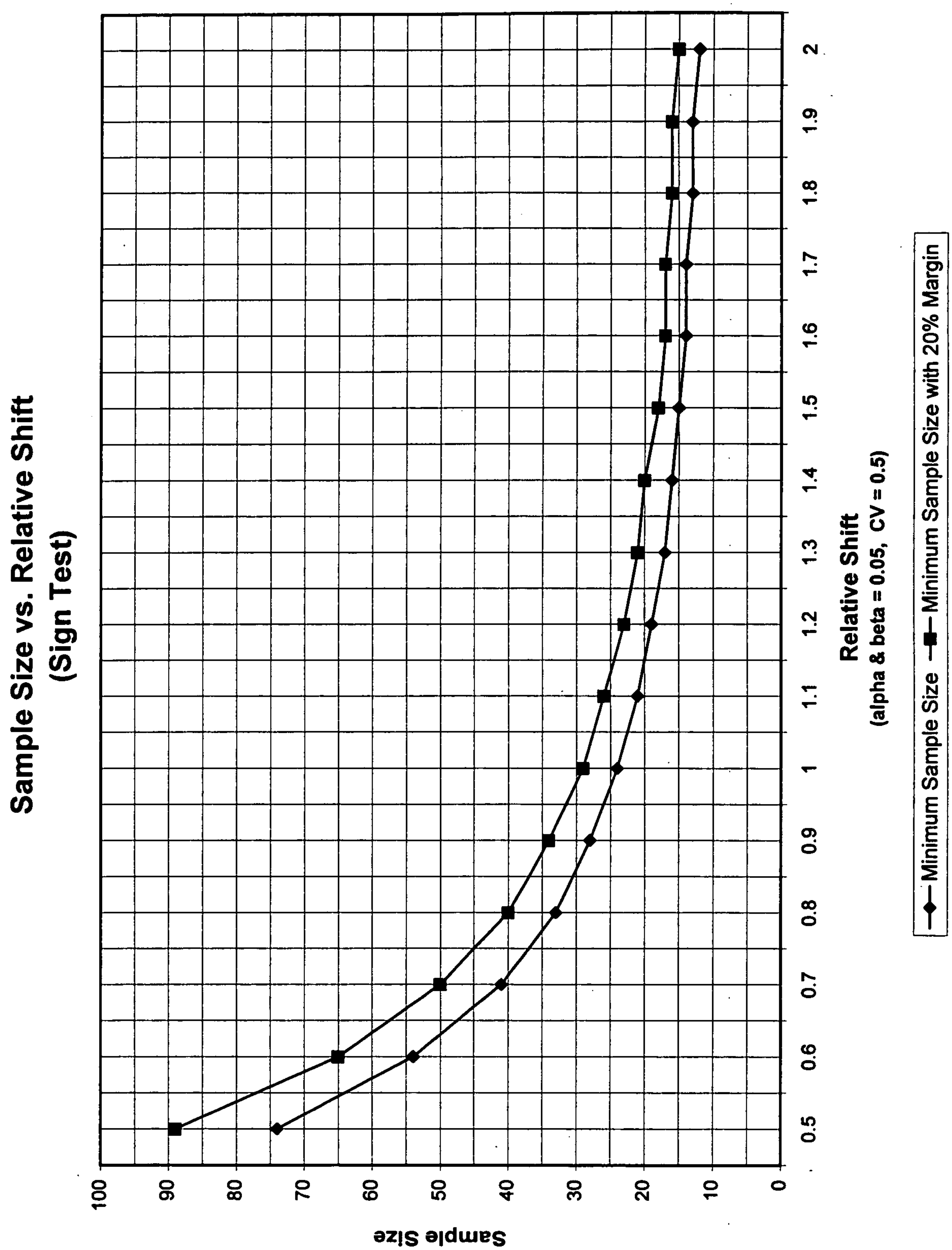

Figure 5–1. Sample Size Comparisons

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The "Sign p" value is an intermediate statistic used to determine the minimum sample size. The Sign p is the estimated probability that a random measurement from the survey unit will be less than the DCGL when the survey unit median is actually at the Lower Boundary of the Gray Region (LBGR) value selected. The Sign p value for a relative shift of 1.0 is picked from MARSSIM, Table 5.4, *Values of Sign p for Given Values of Relative Shift, Δ/σ, when the Contaminant is Not Present in Background.* The Sign p for a relative shift of 1.0 is 0.84135.

The Z statistic is a percentile score corresponding to the accepted probability of decision error at the DCGL and LBGR. The specified acceptable probability of decision error for the D&D of the buildings in the 779 Cluster has been selected as 0.05 for both α and β. Consequently the Z statistic for $Z_{1-\alpha}$ and $Z_{1-\beta}$ are the same value, 1.645.

The number of data points, N, to be obtained to satisfy the Sign test with sufficient statistical power is calculated using the following formula:

$$N = \frac{(Z_{1-\alpha} + Z_{1-\beta})^2}{4(\text{Sign p} - 0.5)^2} \tag{3}$$

$$N = \frac{(1.645 + 1.645)^2}{4(0.841345 - 0.5)^2} = \frac{10.8}{0.466} = 24 \tag{4}$$

To account and compensate for uncertainty in the computations of minimum sample size as well as the possibility that some sample data may be lost or deemed unusable due to analytical and sampling error, anomalous results which are judged to be erroneous, and other errors, minimum sample size computations should be increased by 20 percent and rounded up to obtain sufficient data points to yield the desired power.

Table 5–4. Computed Minimum Sample Sizes per Survey Unit (Sign Test)

Derived Concentration Guideline Level	Computed Sample Size	Sample Size With 20% Margin
Removable Surface Contamination Concentration 20 dpm/100 cm^2	24	29
Total Surface Contamination Concentration 100 dpm/100 cm^2	24	29
alpha = 0.05, beta = 0.05, relative shift = 1.0		

As expected, non-parametric tests require an appreciably greater sample size than a conventional normal means test, but liberate the decision maker from the need to meet the underlying assumption basis of normality. Additionally, sample sizes in the range of 30 are recommended in order to adequately assess the population sample distribution when it is unknown. Since the distribution is unknown, and will likely be altered from its pre-remedial state by decontamination efforts, this indicated minimum sample size supports assumptions necessary to evaluate the residual surface contamination in the 779 Cluster buildings.

A summation of the required number of samples and measurements required to complete the Stage II independent verification sampling of selected survey units is provided in Table 5–5.

Table 5–5. Summary of Stage II Proposed Sample Sizes

Survey Unit	Sample or Measurement Type		
	Smear	Media Sample	Direct Static Measurement
Building 729	29	29	29
Building 729 Subtotal	**29**	**29**	**29**
Building 782	29	29	29
Building 782	29	29	29
Building 782 Subtotal	**58**	**58**	**58**
Building Group (783,727, 780, 780A, 780B)	29	29	29
Building Group (783,727, 780, 780A, 780B)	29	29	29
Building Group (783,727, 780, 780A, 780B), Subtotal	**58**	**58**	**58**
Building 779	29	29	29
Building 779	29	29	29
Building 779	29	29	29
Building 779	29	29	29
Building 779	29	29	29
Building 779 Subtotal	**145**	**145**	**145**
779 Cluster Stage II Subtotal	**290**	**290**	**290**

The total and subtotal numbers of samples bare no statistical significance. Only the number of samples in a given survey unit have a statistical basis. The subtotal and total values are provided to assist in planning and budget processes and to give an overview of the scope of the independent verification sampling effort.

5.4 Sample Allocation Approach

The sample allocation strategy requires a multi-level approach intended to ensure:

1. Greater weighting or priority to survey units with classification indicating greater potential to exceed the allowable radiological concentration,

2. Unbiased survey unit selection from among survey units of the same class and from the same building (or group of buildings) being considered for release by the Contractor,

3. Random selection of the sampling starting point within the selected survey unit(s),

4. Systematic distribution of sample locations within the selected survey unit(s) to ensure representative spatial coverage of the survey unit, and

5. Personnel safety during the execution of the sampling plan.

The physical location of each sample will be determined, identified, and located just prior to sampling based on the sampling allocation protocol, an inspection of the survey unit and building, and the sampling grid established by the Contractor during final status survey. The IVC will advise DOE–RFFO of the proposed sample scheme allocation for each survey unit selected for independent verification, identifying each location which had to be relocated, and the reason for relocation. Drawings of the survey unit will be used, in conjunction with field observations, to ensure that allocated sample locations can be accessed and that data derived from the location will support the DQOs. It is envisioned that the IVC will spend several hours, or more, working to select and identify locations. The result will be a "Field Baseline Sample Allocation." As discussed below, the Field Baseline Sample Allocation may be revised with approval of the IVC Field Team Leader and DOE–RFFO.

DOE is concerned about the safety of persons assigned to collect sample data in these buildings. Some of the buildings in the 779 Cluster are large, two-story structures. All are located in an industrial setting with appreciable personnel safety hazards. Due to inherent personnel safety issues, it may be decided in the field that it is not necessary or reasonable to collect a sample or make a measurement from a location selected through the random-start, systematic process. In such a case, the "Revised Sample Location" protocol outlined in Section 5.4.2 below may be used to relocate a sample in the interest of personnel safety.

5.4.1 Field Baseline Sample Allocation Protocol—Stage II Sample Locations

Figure 5–2 is a sample grid layout for a survey unit. The walls are set flat to assist the process of spatial distribution and sample location recording. The walls have been divided into sampling frames bound by the sampling grid superimposed over the surface of the survey unit.

5.4.1.1 Selection of Survey Units for Independent Verification

1. Obtain from the Contractor a list of each survey unit within a building scheduled for final status survey.

2. Sort the survey units according to radiological survey status classification as defined by the Contractor:

   a) Non-impacted
   b) Impacted, Class 3
   c) Impacted, Class 2
   d) Impacted, Class 1

3. Count the total number of "impacted" survey units in the building.

Note Survey Units classified as "Non-impacted" will not be selected for independent verification..

4. Assign a weight factor (Table 5–6) to each survey unit based on the designated radiological survey status classification.

Table 5–6. Weighting Factors for Survey Unit Radiological Classification

Radiological Survey Status Classification	Weight Factor
Non-Impacted	0
Impacted, Class 3	1
Impacted, Class 2	2
Impacted, Class 1	6
By assigning weighting factors to the survey units based on radiological classification, the independent verification survey will preferably select survey units which have a higher probability of exceeding the applicable DCGLs. Class 1 survey units (the most likely to be contaminated), are three times more likely to be selected than Class 2 units and six times more likely than Class 3 units.	

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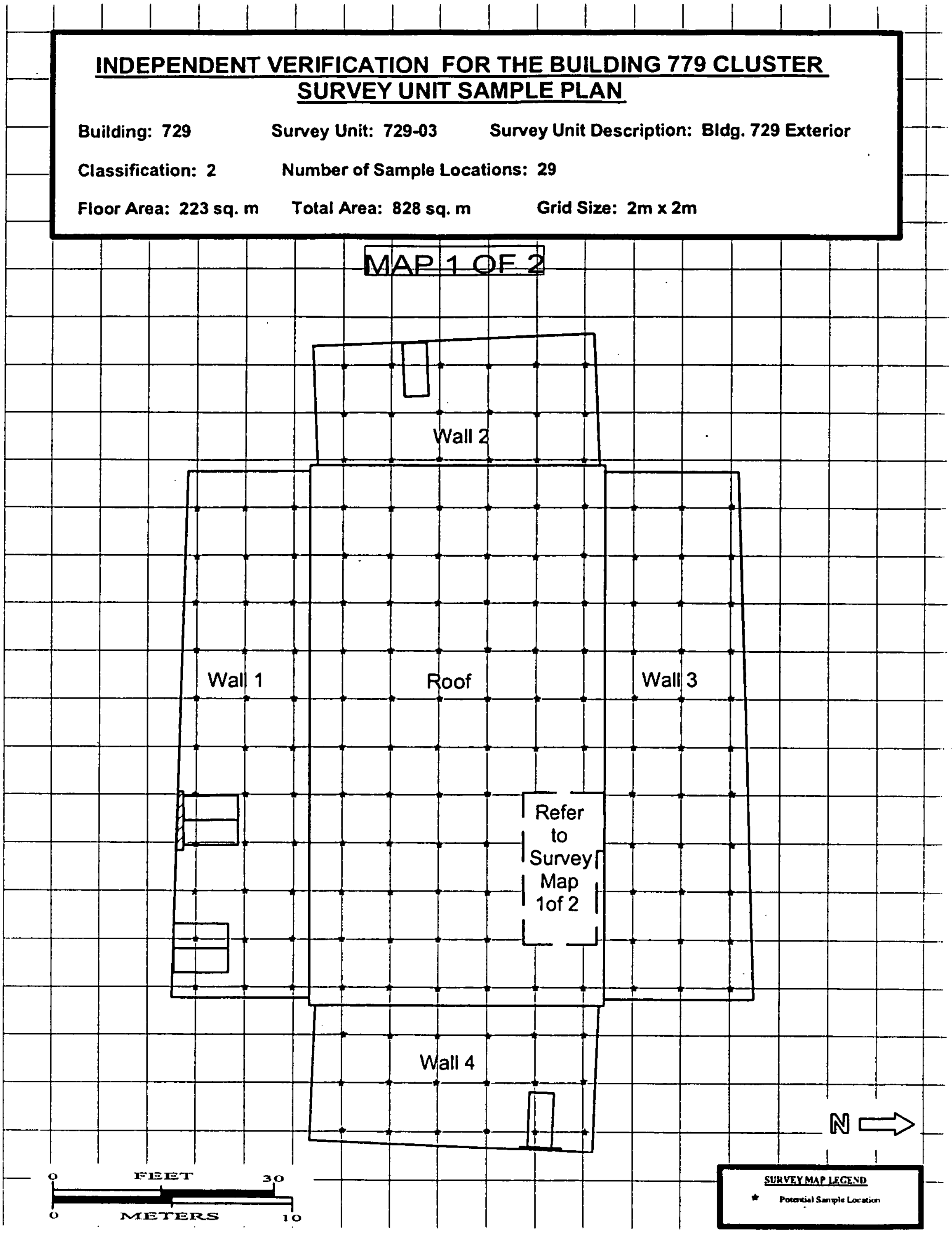

Figure 5–2. Example Grid Layout Establishing a Stage II, Survey Unit Sampling Frame

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5. Select a survey unit(s) to be independently verified by randomly selecting a survey unit number from among all "impacted" survey units in the building.

   a) Select 10 percent of the total number of survey units available for selection in each building undergoing final status survey release.

   b) In buildings (or groups of buildings) where the total number of impacted survey units is less than 20, select at least one survey unit for independent verification.

   c) Acceptable methods include:

      1) "drawing from a hat"
      2) a random number table
      3) a random number generator

   d) **IF** the "drawing from a hat" method is used to randomly select survey units for independent verification,
      THEN replace the selected survey unit "marker" in the hat before randomly selecting the next survey unit. (This is known as sampling with replacement and is designed to ensure that the probability of selection is not altered as the selection process progresses.)

   e) **IF** a survey unit is selected more than one time,
      THEN replace the survey unit marker (if used),
      AND repeat the selection process until the appropriate number of survey units have been identified.

5.4.1.2 The Stage II Field Baseline Sample Allocation Procedure

1. Select a survey unit for independent verification from among the survey units defined by the Contractor in accordance with Section 5.4.1.1 above.

2. Draw a scaled field map of the survey unit selected with all of the walls and overhead set flat.

3. Superimpose the grid layout over the field map drawing.

   a. Indicate the appropriate compass orientation on the map.

4. Label each intersection created by the sampling grid that overlie surfaces in the building to be sampled.

Note Do NOT label intersections that do not overlie surfaces in the building to be sampled.

5. Count the total number of intersections that overlie surfaces in the survey unit to be sampled.

6. Randomly select the first sample location by randomly selecting the starting intersection point. Each intersection should have an equal probability of being selected as the starting point.

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a. Acceptable methods include:

a) "drawing from a hat"
b) a random number table
c) a random number generator.

Note Figure 5-2 grid enumeration begins in the top left corner and proceeds to the right and to the bottom. It is not important to begin the numbering according to a specific compass orientation, although the orientation should be noted before beginning.

7. Determine the systematic sample increment.

   a. Divide the total number of intersection points counted in Step 5 above by 29 (the number of samples and measurements to be collected in each independently verified survey unit).

8. Locate each successive sample by moving to the right and down through the grid by the calculated systematic sample increment.

5.4.2 Revised Sample Location Selection Protocol

As indicated in Figure 5-2, certain portions of a survey unit's surface area may not be available for sampling. These include doorways[a], inaccessible areas, and locations determined to be unsafe for personnel to access.

If the Baseline Field Allocation Protocol places a sample in an inaccessible location, on a surface later found to be non existent (like an open doorway), or in a location which is deemed unsafe to access, the location will be moved to the nearest accessible location within the same survey unit while conforming to the overall spatial coverage theme. Generally, the nearest available location that compliments the goal of even spatial coverage would be the most defensible choice.

Alternate sample locations will be identified in the field by the IVC's Field Team Leader and documented as a revised location selection indicating the reason for relocation.

5.4.3 Illustration of Stage II Field Baseline Sample Allocation Procedure

To illustrate the allocation procedure, an example is performed for a survey unit consisting of the exterior of a building in the 779 Cluster and is depicted in Figure 5-3. The following discussion parallels the procedure that will be completed for each survey unit selected for independent verification to develop a Field Baseline Sample Allocation before sampling begins. In Figure 5-3 each wall is folded out flat and portrayed as if the viewer is looking-on directly from the center of the roof. The sampling grid divides the surface into 2 meter (m) × 2 m cells. The sample points, indicated by stars, and located at the intersection of the horizontal and vertical grid lines were obtained as follows:

1. Select a survey unit for independent verification from among the survey units defined by the Contractor.

[a] Doorways with doors remaining in place are available and appropriate for sampling or measurement. Only samples initially located in doorways without doors present no surface for measurement and must be relocated.

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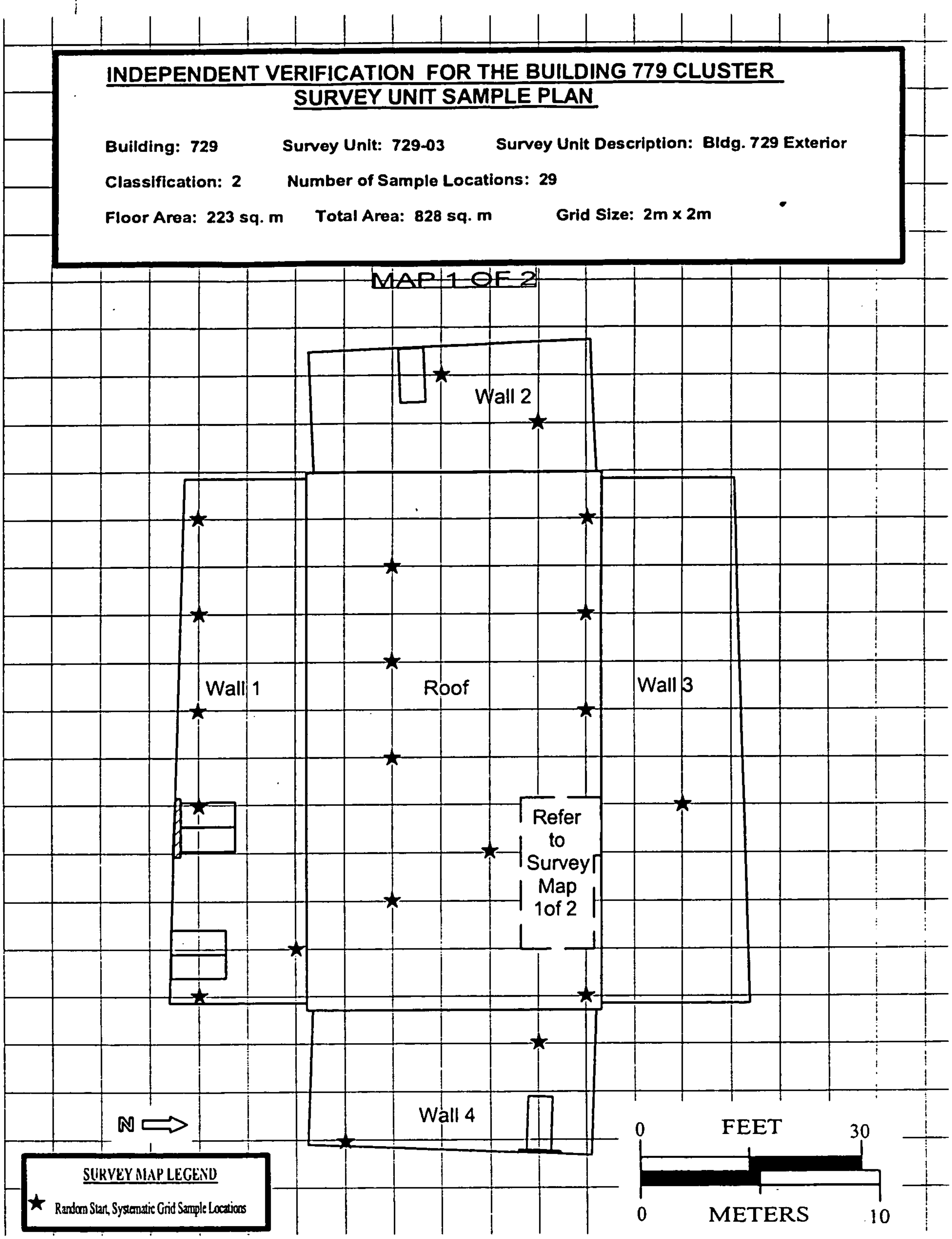

Figure 5–3. Illustration of Stage II Sample Allocation Scheme

2. A scaled field map of the selected survey unit was made with all of the walls set flat and the grid layout superimposed (Figure 5–3).

3. Each intersection point created by the grid, which overlies a surface to be sampled is labeled.

4. The total number of intersection points that overlie surfaces in the building to be sampled is determined to be 160.

5. The starting point is randomly selected by using a computer-generated random number between 1 and 160.

6. The systematic sample increment is determined to be 8 (160 ÷ 20). In this case 9 of the 29 scheduled samples are distributed on another section of Building 729 (Map 2 of 2).

7. Each successive sample is located and marked (in this case with a star) on the field map by moving to the right and down through the grid by the calculated systematic sample increment.

8. The sample location on the double doors on wall #1 was randomly selected. If it is subsequently found that the doors have been removed, the Revised Sample Location Protocol would be used to relocate this sample to the location just north of the randomly selected location.

There are 160 grid intersections representing potential sample locations in survey-unit X. Each intersect point has a 1 in 160 chance of being selected as the starting cell. Each intersect point has a 1 in 8 chance (20 samples, 160 intersections, 12.5 percent chance) of being sampled. Each succeeding sample will be systematically located 8 intersect points "down" the grid system giving equa-proportions.

The visual array of samples displayed on Figure 5–3 is typical of the Field Baseline Sample Allocation to be developed by the IVC prior to sampling. This example exhibits good spatial coverage. There is no apparent "clustering" of samples nor extensive surface area without a sample location. An important limitation will be the number of samples needing relocation as a result of inaccessibility. In the field, this exercise will be completed for each survey unit selected for independent verification.

5.5 Surface Contamination Anomaly Characterization

A consideration in the decision rule is the evaluation of the maximum measured total surface contamination concentration against the Elevated Measurement Comparison DCGL ($DCGL_{EMC}$). The potential for the existence of nonuniform (anomalous) concentrations is reasonably high, although significantly elevated concentrations are very improbable. Areas where there is a greater potential for elevated contamination due to past operations have been radiologically controlled and surveyed frequently. Further, areas with significantly elevated concentrations of contamination are likely to have been identified by these frequent surveys and these areas are likely to have been subjected to remedial decontamination actions prior to the implementation of the final status survey. This aspect was evaluated by the Contractor (RMRS1997a, RMRS 1997b, RMRS 1998c) in deriving the DCGLs for the Building 779 Cluster.

The Contractor has established the $DCGL_{EMC}$ as a maximum value equal to three times the allowable total α surface contamination concentration.

5.5.1 Field Identification of Anomalies

The IVC will not investigate field-measured values, which exceed or might possibly exceed the $DCGL_{EMC}$ value. The scanning technique employed by the Contractor is better suited to the investigation of locally elevated concentrations of surface contaminants. Rather, the IVC will perform a simple single point comparison of each data point gathered from implementation of the IVC's Field Baseline Sample Allocation strategy. A single datum point above the $DCGL_{EMC}$ will be referred to the Contractor for resolution and identified as a failure to meet the $DCGL_{EMC}$ for the affected survey unit.

As an operational rule, field measurement results exceeding approximately 300 dpm/100 cm^2 gross alpha activity signify the need for the Contractor to conduct an exploration of areal extent and determine the need for further remedial action. The field detection of a single datum point above the $DCGL_{EMC}$ will be immediately referred to the Contractor's final status survey Radiological Engineer and DOE–RFFO contact for resolution.

6.0 Measurement Methods and Quality Control

This section will present details of the sampling methods including measurement techniques, sampling procedures, and measurement system quality issues.

6.1 Measurement Methods

This SAP prescribes three basic measurements in order to determine compliance with the DQOs. The three basic measurement types required are:

- Smear Surveys—collected from the selected sample locations on the impacted surface of the survey unit and analyzed in the laboratory for gross alpha activity.
- Direct Static Field Measurements—used to obtain the total α surface contaminant concentration as measured by direct surface emission from impacted surfaces.
- "Surface Media Samples"—obtained from the surface veneer of the impacted surface and analyzed in the laboratory for transuranic and uranium series alpha activity.

In addition, some scanning methods may be used, as appropriate, to provide the Contractor's Radiological Engineer and the DOE–RFFO contact with qualitative information about the extent of contamination concentration anomalies. No scans will be used to quantify radioactivity concentrations, to draw conclusion about the radiological condition of any surface, or for inclusion in the independent verification final survey report.

6.2 Field Measurement of Surfaces

The principal field measurement method will be direct assessment of surface activity using a gas-filled chamber with a thin entrance window and operating in the proportional range of the gas amplification curve (commonly referred to as a gas proportional counter). Timed static measurements will be made at the selected sample locations prior to the collection of a surface media veneer. Table 6–1 identifies technical specification information on the technique.

Table 6–1. Direct Field Measurement Instruments for Surfaces

Element	Description
Instrument	Eberline E–600 Multipurpose Radiation Survey Instrument
Probe	Eberline HP-100 fitted with an Eberline "Smart-pack"
Procedure	Procedure IVP-RFETS-03, Appendix A, See Section 6.3

Notes: 1. Instrument selection is subject to revision (with an equivalent instrument).
2. Instruments are calibrated by Eberline. Probes are calibrated according to DOE–GJO Calibration Contractor's (Wastren) overarching calibration program and procedures which include quality assurance (QA) and quality control (QC) measures.
3. Instrument trains are response checked according to Procedure IVP–RFETS–01, Appendix A.

The instrument type and technology outlined in Table 6–1 is the recommended (EPA 1997) and commonly used type for measuring surface contamination levels from alpha emitting sources of radioactive contamination. It is reliable, readily available, and reasonably easy to use by trained

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personnel. Modifications to the general method/equipment for use in the Building 779 Cluster independent verification sampling include:

- Modification of the probe gas ports to operate as sealed gas detectors instead of gas flow detectors. The modification consists of the addition of sealed check valves with quick disconnects to both the inlet and outlet gas ports. When mated with the male quick disconnect fitting, the check valve opens permitting the flow of counting system gas to purge and recharge the detector volume. Disconnected, the check valve seals the detector volume, trapping a volume of fresh counting system gas, which can be used remotely (physical probe modifications).

- Modification of the probe to include "feet" mounted on the inactive face of the probe. The result is an application-specific geometric alignment, which will eliminate a major potential source of sampling error and permit geometrically consistent measurements.

- Instrument, calibration memory chip, and probe train calibrated to a Pu-239 source in the alpha channel with application specific geometry. The 5.156 MeV Pu-239 alpha is a good match for the average alpha energy expected with a WGP mixture of transuranic radionuclides.

- The E-600 field instrument will be fitted with a portable bar code reader which will permit data logging associated with the specifically identified and labeled sample identification number. Inclusion of the bar code reader should permit resolution of the majority of data usability issues related to human error in the data recording and transcription process.

6.2.1 Field Measurement Analytical Levels

The direct field measurement method described in Table 6–1 is widely used in health physics and radiation protection practice for assessing radioactive surface contamination and for making risk management decisions. Based on EPA's guidance, the method described in Table 6–1 would be categorized as Analytical Level II, mainly because it is a field-based measurement as opposed to a laboratory method (EPA 1988). However, based on the calibration and technical specifications embodied in the procedure, they are directly comparable to EPA's Analytical Level III which is commonly encountered in the Superfund program. According to the EPA *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA* (EPA 1988), Analytical Level III data is applicable for risk assessment, primary responsible party (PRP) determination, site characterization evaluation of alternatives, engineering design, and monitoring during implementation.

There is also precedent for using this method for the type of decisions specified in the DQOs. Direct field measurements comparable to those identified in Table 6–1 are specified for use in the Contractor's Closeout Radiological Survey Plan (RMRS 1998c) and are recommended in MARSSIM guidance (EPA 1997). This measurement type is used by DOE–GJO and approved by the EPA, Region VIII as a basis for estimating human cancer risks in the *Monticello Mill Tailings Site Operable Unit III Baseline Human Health Risk Assessment* (DOE 1998b) and for supporting risk management decisions in numerous Supplemental Standards Applications involving Monticello Vicinity and Peripheral Properties. On this basis, the method specified in Table 6–1 is regarded as adequate and appropriate for supporting the independent verification project DQOs.

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6.3 Laboratory Analytical Measurement Methods

Two of the sample methods used require the use of an analytical laboratory to perform the measurement of radioactive concentration. Solid media samples consisting of potentially contaminated surface veneers and smear samples will each be collected in the field and sent to the IVC's laboratory. The GJO Analytical Laboratory has been selected to perform these analytical measurements because: 1) it is one of the foremost radioanalytical laboratories in the region, 2) it has extensive experience performing the measurements required, 3) because it is wholly independent from the Contractor's laboratory, and 4) it uses readily accepted EPA recommended methods. Solid media samples will require extensive digestion and sample preparation before the radioactivity can be appropriately assessed. Table 6–2 details the laboratory methods to be used.

Table 6–2. Laboratory Methods and Measurement Instrument

Element	Description
Smear Sample Counting Method	Procedure RC–8 (Rev. 3, 12/23/92), *Determination of Gross-Alpha and Gross-Beta Activity of Air Filters and Smears*, (WASTREN, Inc.).
Instrumentation	Two Gas Proportional, Low-Background, Alpha/Beta Counting Systems are available: • Canberra 2402 α/β • Gamma Products G5000 Series Each instrument has specific operating characteristics providing the analytical flexibility that may be necessary for analyzing smear samples.
Laboratory Quality Assurance	GJO Analytical Laboratory procedures are governed by QA/QC procedures specified in the *Handbook of Analytical and Sample-Preparation Procedures* (WASTREN, Inc.) and the *Administrative Plan and Quality Control Procedures* (WASTREN, Inc.).

Table 6–3. Laboratory Methods and Measurement Instrument

Element	Description
Sample Preparation	Procedure RC–19 (Rev. 6, 4/28/99). Determination of Am, Curium, Pu, Th, and U in Water, Soil, Filters, and Organic Samples by Extraction Chromatography and α Spectrometry.
Surface Media Sample Counting Method	Procedure RC–19 (Rev. 6, 4/28/99). Determination of Am, Curium, Pu, Th, and U in Water, Soil, Filters, and Organic Samples by Extraction Chromatography and α Spectrometry.
Instrumentation	Multiple Detector Array Alpha Spectrometry System: • 1 Inch PIPS with Canberra Alpha Management Software (AMS) Model 48-0721, Ver. 1.0, 9/95
Laboratory Quality Assurance	GJO Analytical Laboratory procedures are governed by QA/QC procedures specified in the *Handbook of Analytical and Sample-Preparation Procedures* (WASTREN, Inc.) and the *Administrative Plan and Quality Control Procedures* (WASTREN, Inc.).

The analytical systems described in Tables 6–2 and 6–3 are commonly used for measuring plutonium and uranium series contamination. They have been used extensively in assessing contamination associated with wastes containing plutonium-contaminated materials and residue;

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their use at GJO is standard practice. They are reliable, well understood, and reasonably easy to implement by trained analytical laboratory personnel.

Based on EPA's terminology, the methods described in Tables 6–2 and 6–3 would be categorized as Analytical Level V because they are nonconventional in the EPA's Contract Laboratory Program (CLP) (EPA 1988). However, comparing the level of quality assurance (QA) and QC embodied in these procedures, they are comparable to EPA's CLP Analytical Level IV, which is the Agency standard for enforcement actions. According to EPA, Analytical Level IV data is applicable for risk assessment, PRP determination, evaluation of alternatives, and engineering design (EPA 1988).

Standard laboratory reporting of results will include:

- Analyte (e.g., gross alpha, Pu-239)
- Result (e.g., 50 picoCuries (pCi), *reported as activity per sample*)
- Sample weight (e.g., 25 grams, *reported as activity per sample*)
- Error at 95 percent confidence (e.g., ± 10 pCi)
- Date of analysis (e.g., 10/20/97)
- Analytical method (e.g., RC–1)

Additionally, the laboratory will provide a case narrative describing extraction and analysis performed, as well as the analyst's notes and observations. It is possible that the analyst will need to exercise professional judgement in the digestion and extraction procedure to deal with challenging matrices (e.g., concrete, paint, roofing material residue, oxidized materials). QC information including control charts, daily instrument checks, and internal duplicates, matrix spikes, and standards performance will also be provided or referenced so the data can be validated and DQA conducted.

6.4 Field Sampling Procedures

Two field sampling procedures will be required.

1. *Radiological Surface Contamination Surveys*—Procedure IVP-RFETS-03, (Direct Static Measurements).

2. *Surface Sampling to Determine Residual Surface Contamination*—Procedure IVP-RFETS-04, (Smear and Surface Media Samples).

In addition to the two basic sampling procedures, supporting field procedures are necessary. These supporting procedures include:

1. *Portable Radiation Survey Instrument Response Checks*—Procedure IVP-RFETS-01

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2. *Instrument Background Determination*—Procedure IVP-RFETS-02

3. *Managing Electronic Data*—Procedure IVP-RFETS-05

Each of the identified procedures is attached in Appendix A to this SAP.

6.4.1 Determining the Need for Surface Media Samples

Surface media samples are indicated when there is a credible potential for radiological contamination to be either: 1) embedded in the surface, or 2) between or beneath layers of a surface coating (e.g., paint, tile, roofing material, etc.)

Based on the historical knowledge available, it is apparent that in many cases spills of radioactive material were grossly decontaminated and then paint was applied over the contaminant to "fix" it in place. Other mechanisms also suggest the possibility of radioactive contamination being covered over by layers of materials through the years of facility operations. Surface media samples are designed to assess the potential for and activity of these shallow deposited contaminants. Samples are necessary because since the alpha radiation signal produced by the contaminants of concern is likely to be significantly attenuated by even the smallest density thickness material overlying the contaminant layer. If a surface selected for independent verification measurement is bare (that is, it has no surface coating or residue from a coating, and the building surface substrate is exposed) surface media samples are not automatically required. Surface media samples will be required when the surface selected for independent verification measurement:

- Has a surface coating, or
- Has a residue from a previously applied coating, or
- Has detectable radioactivity (activity greater than the critical level [L_C]) as indicated by direct static measurement, even if there is no visible evidence of a coating having been applied in the past.

If the Baseline Sample Allocation identifies fewer than 24 sample location meeting the inclusion criteria above, then use the Revised Sample Location Selection Protocol (Section 5.4.2) to identify additional sample locations meeting the criteria.

6.5 Measurement Sensitivity

Measurement sensitivity is an important component of the sampling and analysis plan because it is critical that measurement systems be capable of detecting the benchmarks that guide decisions including the DCGL comparisons. This section discusses measurement system sensitivity in light of the specific benchmark comparisons.[a]

[a] Measurement sensitivity computations are derived from the basic detection limit relationship $L_D = k + 4.65\sqrt{B}$. This relationship as derived by Curie (1968) set the constant *k* at 2.71. Since that time it has been shown (Brodsky 1992) and generally accepted that a constant factor of 3 is more appropriate. The IVC will calculate field measurement sensitivity using the constant factor 3. The GJO Analytical Laboratory calculates detection limits for each sample processed using the constant factor 2.71. Thus, the use of both factors (2.71 and 3) appear in this SAP depending upon which agency is making the measurement. While there is an appearance of internal conflict within the SAP on this point, the authors considered it more important to disclose the difference than to provide the appearance of symmetry. Further, the use of 2.71 versus 3 has no significant bearing on the calculations presented or the suitability of any measurement method prescribed in this SAP.

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6.5.1 Direct Measuring Field Instrument

The direct measurement field instrumentation specified in Section 6.1 are reliable devices with adequate detection sensitivity and are suitable for timed static field measurements to compare with the total surface contamination concentration DCGL. The following formulation is used to predict the minimum detectable concentration, in dpm/100 cm^2, for the E-600 survey instrument using the Eberline HP-100 detector probe.

$$MDC = \frac{3 + 4.65\sqrt{C_b}}{T_s \times \frac{A_P}{100\ cm^2} \times \varepsilon_T} \qquad (5)$$

Where: MDC = the minimum surface activity concentration above background radioactivity (in dpm/100 cm^2) that can be measured with 95 percent confidence.
C_b = the total number of background counts over the sample count period (T).
T_s = Sample count time (in minutes).
A_P = Probe size (in cm^2).
ε_T = Counting system efficiency in counts/disintegration.

Using conservative estimates of the parameters affecting the minimum detectable concentration (MDC) of the static field measurement, an *a priori* assessment of the MDC can be determined. This value represents the worst plausible case measurement conditions and yields the highest expected measure of the detection sensitivity for the analysis. As such, the *a priori* estimate of the MDC serves as a figure of merit about the capability of the measurement. The following table and calculations define the *a priori* MDC estimates for the static alpha surface contamination measurements using the E-600 and the HP-100 gas proportional detector probes identified.

Table 6–4. Static Surface Contamination Measurement

Parameter		Value Used	Remarks
C_b	Background Counts	4.5	Value used is the product of the maximum expected instrument background count rate (3 cpm) and sample count time.
T_s	Sample count time (in minutes)	1.5	Count time programmed into the calibrated instrument specifically for this sampling event
A_P	Probe size	100	In cm^2.
ε_T	Instrument system efficiency in counts/disintegration	0.18 (18%)	Nominal alpha efficiency for the HP-100 thin window gas proportional probe determined with a Pu-239 calibration source is 26%. Actual efficiency for each individual probe is programmed into the memory chip of the probes smart pack and is typically better than 18%.

These values predict a worst plausible case MDC for the static field measurement to be 48 dpm/100 cm^2 as shown in the following calculation.

$$MDC = \frac{3 + 4.65\sqrt{4.5}}{1 \times 1.5 \times 0.18} = 48\ dpm/100\ cm^2 \qquad (6)$$

To show the effect of background[a] count rate and count time on the MDC, sensitivity of MDC for the HP-100 probe is illustrated in Figure 6-1 for count times ranging from 0.1 to 5 minutes and background count rates (counts per minute [cpm]) ranging from 0.5 to 5. The illustrated count time and background count rate ranges span the plausible and expected field conditions. Key points illustrated in Figure 6-1 are:

- Most importantly, MDCs over the range of expected conditions are lower than the total surface contamination concentration benchmarks (by ≈ 50 percent). Appropriate sensitivity is a key requirement of EPA Guidance (EPA 1992).
- The MARSSIM objective to use measurement methods and instruments which establish MDCs (as a measure of sensitivity) approximately 50 percent below the DCGL benchmark being measured.
- MDC improves (sensitivity increases) as count time increases.
- MDC improves as background count rate diminishes.

In practice, the instrument used for field measurement will be calibrated to respond directly in units of dpm/100 cm^2. As such, background collected in the field will be presented in these units instead of counts or cpm. Nominally, a background count rate of 2 cpm yields an instrument background of approximately 13–15 dpm/100 cm^2. The fact that the instrument presents the background activity in units other than counts or cpm does not change the counting statistics of the measurement and does not affect the MDC of the instrument. Background measurements in the field will be made using the scaler mode algorithm built into the E-600 instrument in accordance with the Procedure, *Instrument Background Determination*, IVP-RFETS-02, Appendix A. Background will be acquired for the same increment of time as used for making static surface measurements.

Figure 6–1 demonstrates that instrument MDCs are adequate to detect the total surface contamination concentration measurement benchmark. Furthermore, if necessary, sensitivity can be augmented readily in the field by increasing the count time. Since sensitivity and MDC are related to and significantly influenced by background, Figure 6–1 underscores the need to establish in-the-area instrument background on a frequent periodic basis during sampling activities.

The Critical Level (L_C) is the smallest count rate (amount of activity) which can be distinguished from the instrument background count rate. Responses above this value are determined to be "greater than background," although one cannot confidently quantify the activity at this level. The L_C is useful in this SAP because it can be used as a qualitative measure to establish a trigger level to indicate the need to collect a surface media sample or to indicate when a sufficient surface media sample has been collected.

[a] Background in the context of this SAP is the inherent instrument background due to electronic noise and cosmic radiation influences. Specifically excluded from this definition of background is the radiation contribution from concentrations of the contaminants of concern even though they may be present in detectable concentrations in background (e.g., uranium in concrete).

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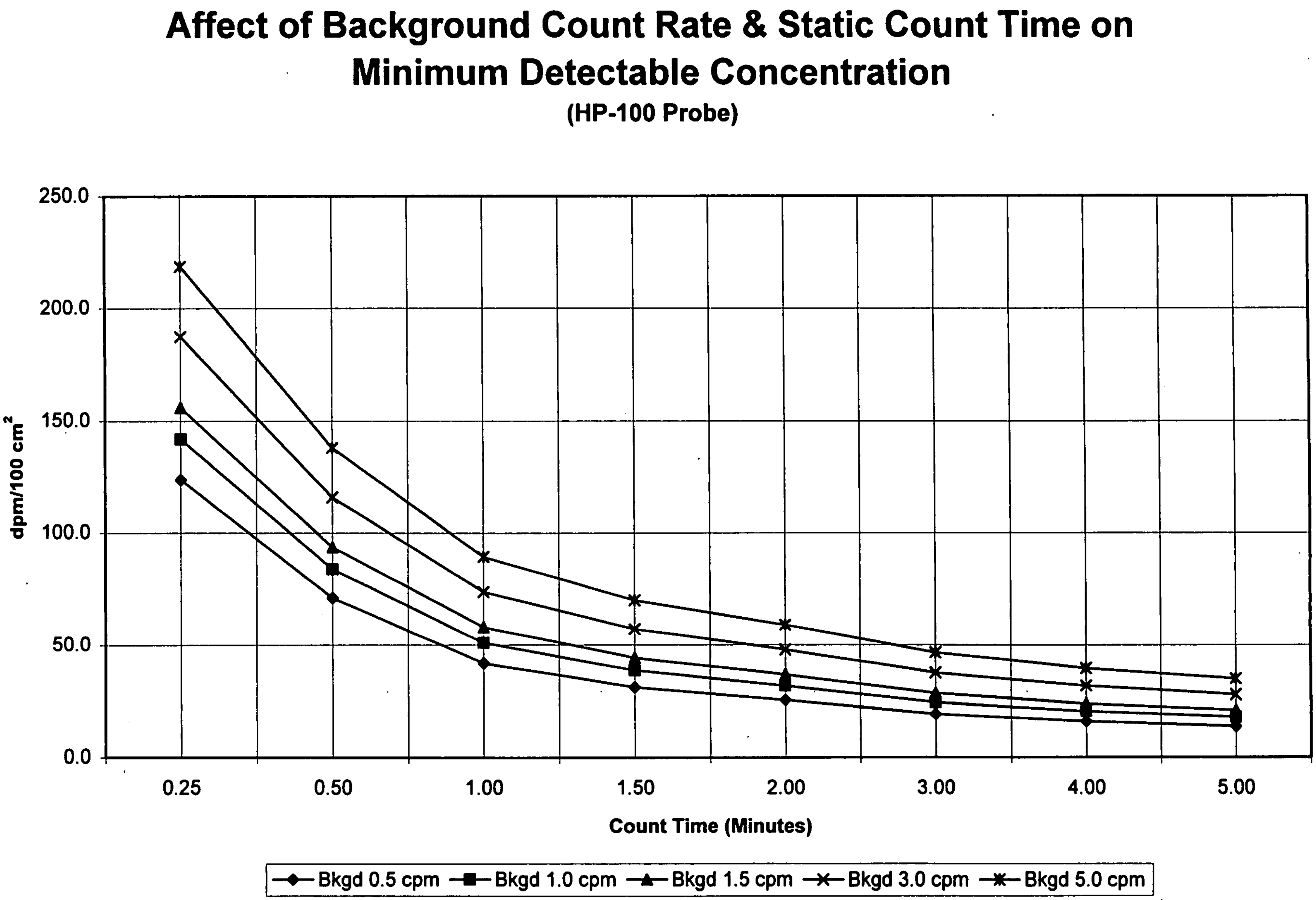

Figure 6–1. Sensitivity of Minimum Detectable Concentration to Background and Count Time

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$$L_c = 2.33\sqrt{B} \tag{7}$$

where: B = the number of background counts expected over the specified counting time period.

Assuming background is 3 cpm, efficiency is 15 percent, and count time is 1.5 minutes, the L_c expressed in units that direct field measurement instruments will report, is:

$$L_c = 2.33\sqrt{4.5} = 3.3\,\text{cpm} = 22\,\text{dpm/100 cm}^2 \tag{8}$$

To show the effect of background count rate and count time on the L_c, sensitivity of L_c for the HP-100 probe is illustrated in Figure 6–2 for count times ranging from 0.1 to 5 minutes and background count rates (counts per minute [cpm]) ranging from 0.5 to 5. The illustrated count time and background count rate ranges span the plausible and expected field conditions.

6.5.2 Laboratory Sensitivity

Laboratory sensitivity will be ensured through contract specification. The Contract Required Detection Limit (CRDL) for laboratory reporting is specified to the laboratory for each type of analysis to be performed. The CRDL specified for gross alpha activity smear sample analysis is 2.5 pCi (approximately 6 dpm). The CRDL specified for alpha isotopic activity analysis of surface media samples is 2.5 pCi per sample per transuranic nuclide and 10 pCi per sample per uranium series nuclide. Based on prior experience and consideration of the *a priori* calculations of the MDAs for the gross alpha and alpha spectrometry analyses to be performed, this specification will be readily achievable by the GJO Analytical Laboratory.

6.5.2.1 Sensitivity of Gross Alpha Activity Analysis of Smears.

The GJO Analytical Laboratory uses the following formulation to determine the minimum detectable activity for gross alpha analysis performed on smear samples submitted. Since there is no sample preparation required for gross alpha counting of smear samples, the chemical yield (Y) is effectively 100 percent.

$$\text{MDA} = \frac{2.71 + 4.65\sqrt{C_b}}{T_s \times S \times Y \times \varepsilon_T \times 2.22\,\frac{\text{dpm}}{\text{pCi}}} \tag{9}$$

Where: MDA = the minimum activity above background radioactivity (in dpm/100 cm^2) that can be detected with 95 percent confidence.

C_b = The total number of background counts over the sample count period (T).

T_s = Sample count time (in minutes).

S = Sample size (e.g., 100 cm^2, 5 liter, 21 grams, 1 sample).

Y = Fraction of total sample matrix radioactivity yielded (recovered) in the digestion and chemical extraction processes. (Assumed to be 1).

ε_T = Total (sample mass corrected) counting system efficiency in counts/disintegration.

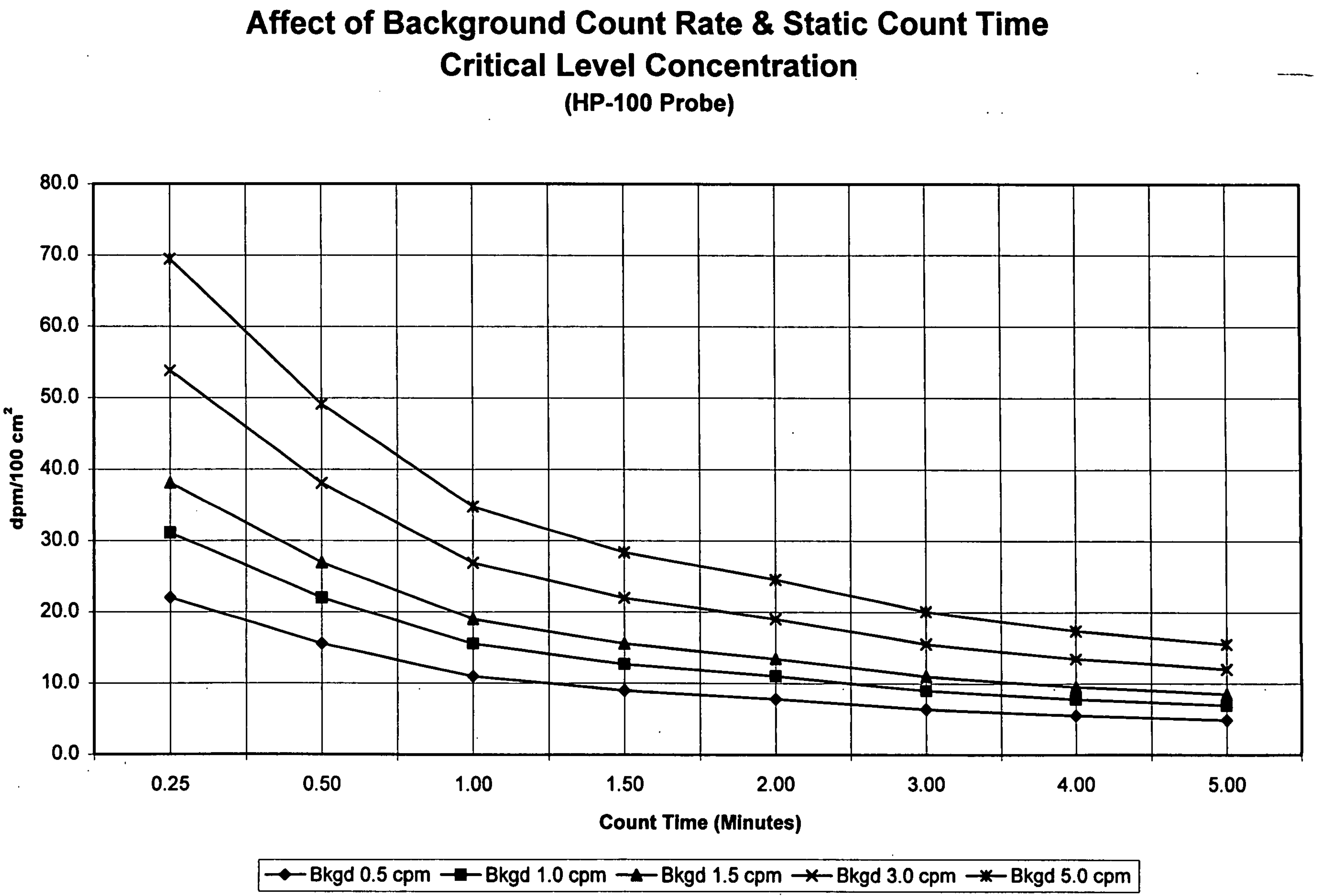

Figure 6–2. Sensitivity of Critical Level (L_c) to Background and Count Time

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Using conservative estimates of the parameters affecting the MDA of the laboratory analysis, an *a priori* assessment of the MDA can be determined. This value represents the worst plausible case analytical conditions and yields the highest expected measure of the detection sensitivity for the analysis. As such, the *a priori* estimate of the MDA serves as a figure of merit about the capability of the analysis. The following table and calculations define the *a priori* MDA estimates for both gross alpha and gross beta measurements of the surface media samples that will be analyzed by the GJO Analytical Laboratory.

Table 6–5. Gross Alpha Analysis

Parameter		Value Used	Remarks
C_b	Alpha background counts	1.5	Value used is the product of the instrument background count rate (0.15 cpm) and sample count time.
T_s	Sample count time (in minutes)	10	Shortest count time typically used for gross alpha counting analysis.
S	Sample size	1	All activities reported as "per sample." Field collection of the surface media samples will cover an area of at least 100 cm^2. Samples collected over areas larger than 100 cm^2 will result in even lower overall detection sensitivity.
Y	Fractional yield of radioactivity (recovered) in the digestion and chemical extraction processes	1	Default Laboratory assumption; corroborated by analyzing a LCS.
ε_T	Counting system efficiency in counts/disintegration	0.15 (15%)	Efficiency used is the smallest alpha efficiency expected .

These values predict a worst plausible case MDA for the laboratory's gross alpha activity analysis to be 2.5 pCi per sample as shown in the following calculation.

$$\mathrm{MDA} = \frac{2.71 + 4.65\sqrt{1.5}}{10 \times 1 \times 1 \times 0.15 \times 2.22} \tag{10}$$

$$\mathrm{MDA} = \frac{8.4}{3.33} = 2.5\,\mathrm{pCi} \tag{11}$$

Assuming the sample was collected over a 100 cm^2 area, the MDA expressed in units compatible with the DCGLs would be 5.6 dpm/100 cm^2. This is well below the critical measurement sensitivity corresponding to the $\mathrm{DCGL_W}$ for removable surface contamination (i.e., 20 dpm/100 cm^2) and within the specified CRDL.

$$\mathrm{MDA} = \frac{2.71 + 4.65\sqrt{1.5}}{10 \times 100\,\mathrm{cm}^2 \times 1 \times 0.15 \times 2.22} \tag{12}$$

$$\mathrm{MDA} = \frac{8.4}{333} = \frac{0.025\,\mathrm{pCi}}{\mathrm{cm}^2} = \frac{5.55\,\mathrm{dpm}}{100\,\mathrm{cm}^2} \tag{13}$$

6.5.2.2 Sensitivity of Alpha Spectrometry Analysis for Surface Media Samples

The GJO Analytical Laboratory uses the following formulation to determine the minimum detectable activity for alpha spectrometry analysis performed on surface media samples. For purposes of demonstrating sufficient detection sensitivity, it is assumed that the sample digestion and chemical extraction processes used will yield (or recover) at least 50 percent of the uranium and actinide series radioactivity present in the sample matrix. In order to validate the assumption of fractional yield (% recovery) in the digestion and chemical extraction process (and to adjust counting time for a non-conservative value if necessary), the analyst adds a tracer nuclide. Measurement of the tracer nuclide permits the analyst to determine and report the actual chemical yield for each sample.

$$MDA = \frac{2.71 + 4.65\sqrt{B}}{q \times k \times \varepsilon \times Y \times E_1} \qquad (14)$$

Where: MDA = the minimum activity above background radioactivity (in dpm/gram) that can be detected with 95 percent confidence.

B = The total number of background counts summed over the sample count period (E_1).

q = Sample size (e.g., 10 gram).

k = unit conversion constant, 0.037 becquerels per picocurie.

ε = Counting system efficiency in counts/disintegration.

Y = Fraction of total sample matrix radioactivity yielded (recovered) in the digestion and chemical extraction processes (assumed to be 0.5).

E_1 = Sample count time (elapsed live count time in seconds).

Using conservative estimates of the parameters affecting the MDA of the laboratory analysis, an *a priori* assessment of the MDA can be determined. This value represents the worst plausible case analytical conditions and yields the highest expected measure of the detection sensitivity for the analysis. As such, the *a priori* estimate of the MDA serves as a figure of merit about the capability of the analysis. The following table and calculations define the *a priori* MDA estimates for the alpha spectrometry measurements of the surface media samples that will be analyzed by the GJO Analytical Laboratory.

Table 6–6. Alpha Spectrometry Analysis

Parameter		Value Used	Remarks
B	Alpha background counts	2.0	Value used is for the detector with the highest instrument background and is derived by taking the product of the background count rate and sample live count time.
q	Sample size (mass of the sample aliquot)	0.75 grams	Actual mass of the sample aliquot is determined by the analyst based on the material matrix. All activities reported as "per sample" taking into account the mass of the aliquot measured and the total mass of the sample submitted. Field collection of the surface media samples will cover an area of at least 100 cm^2. Total sample mass is typically less than 50 grams.
ε	Counting system efficiency in counts/disintegration	0.20	Efficiency used is the alpha efficiency corresponding to the minimum expected efficency for any of the detector chambers used.
Y	Fractional yield of radioactivity (recovered) in the digestion and chemical extraction processes	0.5	Default Laboratory assumption; corroborated and adjusted by analyzing a LCS.
E_1	Sample count time (elapsed live time in seconds)	80,000	Count time typically used for alpha spectrometry counting analysis. Value is ≈ equal to 24 hour real time count.

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These values predict a worst plausible case MDA for the laboratory's alpha spectrometry analysis to be 0.063 pCi per gram per isotope as shown in the following calculations.

$$MDA = \frac{2.71 + 4.65\sqrt{2}}{0.75 \times 0.037 \times 0.20 \times 80{,}000 \times 0.5} \tag{15}$$

$$MDA = \frac{9.29}{222} = 0.042\,\text{pCi/g} \tag{16}$$

Assuming the sample has a total mass of as high as 50 grams and was collected over a 100 cm^2 area, the MDA expressed in units compatible with the DCGLs would be 4.6 dpm/100 cm^2. This is well below the critical measurement sensitivity corresponding to the $DCGL_W$ for total transuranic series activity as measured by surface media sample (i.e., 100 dpm/100 cm^2) and within the specified 2.5 pCi/sample CRDL.

$$MDA = (0.063\,\text{pCi/g}) * (50\text{g}/100\,\text{cm}^2) = 2.1\text{pCi}/100\,\text{cm}^2\ \text{Sample} \tag{17}$$

$$MDA = \frac{2.1\ \text{pCi}}{100\ \text{cm}^2} \times \frac{2.22\,\text{dpm}}{\text{pCi}} = \frac{4.6\,\text{dpm}}{100\,\text{cm}^2}\ \text{per nuclide} \tag{18}$$

The above calculations are shown to demonstrate the sensitivity capabilities available for alpha isotopic measurements performed by the GJO Analytical Laboratory in accordance with their approved standard procedures. It should be noted that the CRDL specified for the uranium series alpha isotopic laboratory analyses of surface media samples is an order of magnitude higher than that specified and demonstrated above for transuranic series nuclides, while the detection sensitivity is roughly equivalent to that for the transuranic nuclides. The laboratory analyst may adjust sample count times (at the laboratory's discretion) as long as the required detection level of 2.5 pCi (6 dpm) per sample per transuranic nuclide is met.

6.6 Quality Control Samples

QC samples will be collected to measure the attributes and performance of the independent verification survey. QC samples will be collected in general accordance with EPA and MARSSIM guidance (EPA 1992) (EPA 1997).

In addition to collecting QC samples that measure the attributes and performance of the IVC's independent verification survey of selected survey units (Stage II Sampling), it is necessary to relate the performance and attributes of the Contractor's final status survey to the IVC's survey. This is an important element in the independent verification process for two reasons. One, the two surveys will, in essence, be pitted against one another to see if the Contractor and IVC independently arrive at the same conclusion. Second, the IVC will not perform a comprehensive survey of the buildings in the 779 Cluster, but will select for independent verification survey only a fraction of the survey units under consideration for release by the Contractor. As discussed in Section 5.1.1, this SAP establishes Stage I independent QC sampling to relate the attributes and performance of the IVC's sampling and analysis to those of the Contractor.

There are then two distinct sets of QC sampling and data that must be obtained in order to independently verify the Contractor's final status survey and conclusions.

6.6.1 Quality Control Data Set #1

This QC data set corresponds to the Stage I sampling outlined in Section 5.1.1.

As the Contractor implements their Closeout Radiological Survey Plan, they will, in certain prescribed situations, collect smears to determine the removable radiological surface contamination concentration and media samples to determine the radiological contaminant concentration beneath (and incorporated within) the exposed surface being surveyed.

As the Contractor collects sample media, the IVC may either collect split or duplicate samples with the Contractor, or provide pre-collected splits, blanks, and blind spikes to the Contractor for analysis. In each case, a portion of the split, duplicate, or spiked sample will be retained by the IVC to be analyzed by a qualified laboratory independent of the laboratory used by the Contractor.

These independent QC samples do not necessarily have to originate from one of the buildings being considered for release under the D&D program for the Building 779 Cluster. Nor do they have to be associated with any specific survey unit or building within the cluster. These samples are designed to assess the overall quality of the Contractor's smear and media sampling and analytical processes through comparative statistical analysis. They do not contribute to the population of samples and measurements used to assess the radiological surface contamination levels of a specific survey unit to the DCGLs by either the Contractor or the IVC. Table 6–5 provides summary totals of the independent QC sample set.

Table 6–7. Independent Quality Control Sample Schedule

Sample Media or Method	Quality Control Sample Type				Number of QC Samples (Stage I) By Media Type / Method
	Duplicates	Replicates	Splits / Spikes	Blanks	
Surface Media Samples	0	0	25	5	30
Smears	0	25	5	5	35
Subtotal	0	25	25	10	60

Some of the QC samples collected in support of the Stage I sampling objective may be used to satisfy the quality objectives for Stage II sampling as well.

6.6.2 Quality Control Data Set #2

This QC data set is used to measure the attributes and performance of the IVC's Stage II survey. Some of the QC data obtained in the Stage I sampling can be used in support of the objective of this second data set. For example, a second set of blank samples would not be necessary to benchmark the IVC's laboratory against a zero activity standard. Direct static measurement methods are used in assessing the total surface contamination concentration in the survey unit.

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The QC method necessary to assess the potential error that might occur with this method is the replicate field measurement.

Table 6–6 identifies the number of Stage II samples by type and the corresponding number of QC samples planned for this QC set. Table 6–7 shows the adjusted number of QC samples planned for Stage II sampling to eliminate unnecessary duplication with Stage I samples available.

- It is anticipated that 290 smears and 290 surface media samples removed from sample locations within the survey units selected for independent verification will be sent to the GJO Analytical Laboratory for measurement. As indicated, these are estimates for planning, not limits on laboratory analyses and the composite number of samples has no particular statistical significance.

- Replicates, splits, and field blanks are specified in accordance with the 1 in 20 rule commonly applied in the environmental industry and cited in guidance (EPA 1988). It is notable that, as with all solid environmental media (e.g., soil), obtaining true duplicates is not feasible. Instead, spiked samples (or split samples) will be submitted. Field blanks will be solid media and smear samples collected in areas assumed or known to be unaffected by the setting.

- For *in situ* measurements, replicate measurements will be obtained by performing a second measurement at the same sample location using the same instrument to measure method precision.

- Trip (i.e., travel) blanks are not necessary and will not be used for this SAP since there is no credible mechanism for the radioactive composition of the samples to be affected in transit. Note that there are no holding-time issues associated with these samples and it is envisioned that all samples collected within the Building 779 Cluster will be transported to Grand Junction at the end of a prescribed rotation of the field activity.

In summary, Table 6–7 illustrates a comprehensive field QC program reflecting prevailing EPA guidance (EPA 1988 and 1992) and MARSSIM applicable methodology (EPA 1997).

Table 6–8. Estimated Numbers of Stage II Samples and Associated Quality Control Samples

Sample Media or Method	Number of Stage II Samples to be Collected [a]	Quality Control Sample Type					Number of Stage II QC Samples Indicated [c]
		Duplicates	Replicates[b]	Splits[b]	Blanks	Spikes	
Surface Media Samples	290	0	0	15	5	0	20
Smears	290	0	15	0	5	5	25
Direct Static Measurements	290	0	15	0	0	0	15
Sub Total	870	0	30	15	10	5	60

[a]Assumed for planning—not a limit. Based on the estimated number of survey units contracted to independently verify (Table 5–5).
[b]Based on 1 in 20 guideline (EPA 1993).
[c]Some of the QC samples collected in support of the Stage I sampling objective may be used to satisfy the quality objectives for Stage II sampling as well.

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Table 6–9. Adjusted Number of Stage II Quality Control Samples

Sample Media or Method		Quality Control Sample Type				
		Duplicates	Replicates	Splits	Blanks	Splits
Surface Media Samples	Stage I Sampling	0	0	25	5	0
	Stage II Sampling	0	0	15	5	0
	Adjusted Overall Number	0	0	40	5	0
Smears	Stage I Sampling	0	25	0	5	5
	Stage II Sampling	0	15	0	5	5
	Adjusted Overall Number	0	40	0	5	5
Direct Static Measurements	Stage I Sampling	0	0	0	0	0
	Stage II Sampling	0	15	0	0	0
	Adjusted Overall Number	0	15	0	0	0
Net Sampling Plan Total		0	55	40	10	5

6.7 Measurement Uncertainty and Data Quality Indicators

Measurement uncertainty in Stage II independent verification sampling will arise from two principal sources: field sampling variation and instrument/laboratory measurement variation. Of the two sources, field sampling variation will likely be the greatest contributor to overall uncertainty because of the inherent logistics of sample collection and the one-of-a-kind aspect of sampling building surfaces. To the extent practicable, field operations will be governed by procedures; survey personnel will be trained. Additionally, one individual who is well-versed in the overall Building 779 Cluster assessment and independent verification approach, the IVC's Field Team Leader, will be on-site at all times to guide and referee unclear situations that may arise, and liaison with the Contractor's final status survey Radiological Engineer and the DOE–RFFO contact. The measurement methods, on the other hand, employee standard instruments, and laboratory procedures whose aspects and nuances are well understood through many years of application. Measurements will also be governed by procedures and the rigors of stringent laboratory QA/QC protocols.

A major activity in determining the usability of the data based on sampling is assessing the effectiveness of the sampling program (EPA 1992). EPA's Data Quality Indicators (DQIs) (EPA 1992, EPA 1997) listed in Table 6–8 will be used in the field and DQA process to provide quantitative and qualitative measures of overall data quality and usability. Key points evidenced by Table 6–8 include:

- Completeness—The project is striving for a 90-percent completeness objective (collection of approximately 261 of the 290 scheduled investigation samples). Attaining or not attaining the objective does not necessarily authenticate or compromise the study. However, a 90-percent completion goal is a desirable performance metric, which indicates nearly all specified data has been acquired. The critical measure of completeness is that a sufficient number of each kind of sample or measurement has been made to achieve the required statistical power to make an informed and well founded decision.

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- Comparability—has been "designed-in" through the overall design of the two-stage, random-start, systematic-coverage sampling approach. In order to gauge comparability of direct field measurements, smear measurements, and surface media samples, the IVC has established the following goals:

  - Less than 10 percent difference between replicate and split samples processed by the IVC's laboratory,

  - An overall regression coefficient of determination (r^2) of approximately 0.75 on paired data, and

  - A standard error of the regression estimate of 10 percent on paired data.

Attaining these comparability benchmarks will signify good comparability between measurements made on a given media using the same instrument types and procedures. Similar comparisons between Contractor analyzed samples and IVC analyzed samples will be drawn to gauge the comparability of the independent assessments. Good comparability between the Contractor's results and those obtained by the IVC form the basis for extrapolation of the independent verification survey result conclusions to survey units not selected for independent verification measurement.

- Representativeness—The random sample design with its unbiased allocation and preference for spatial distribution within the survey unit was intended to ensure representativeness to the extent practicable. Deviations from the unbiased allocation (e.g., selecting locations based on prior knowledge as might be gained from scanning for contamination) will indicate bias and compromise the ability to defend representativeness as a DQI.

- Precision—will be gauged by estimating spatial variability (e.g., posting and gridding the data) and estimating measurement error (blanks, splits, replicates, and counting error according to conventional EPA guidance [EPA 1992]).

The DQA procedure will be performed after data have been collected and validated to assess whether the DQOs have been addressed. According to EPA, DQA involves application of statistical tools to determine whether the variability and bias in the data are small enough to allow the risk managers to use the data to support the decision with acceptable confidence (EPA 1993). The DQA process will be summarized in the final assessment report.

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Table 6–10. Target Data Quality Indicators

DQI	Signature	Action/Remark
Completeness	Less than complete data set could decrease confidence in supporting information	Objective of 90-percent completeness.
Comparability	Affects ability to combine analytical results	Combining or comparing measurement types will be governed by: 1. Comparability between efficiency calibrations of the two systems: Alpha—Pu-238 and Pu-239 (target ≈ ± 10 percent) 2. Professional judgement and field observations
Representativeness	Non-representativeness increases or decreases Type I error depending on the bias.	Sample allocation will be, to the extent practicable, unbiased based on study design discussed in Section 5.1 and Section 5.4.1.
Precision	Lack of analytical precision results in an increase in the data variability and higher estimates of measurement uncertainty.	Field and laboratory procedures will be governed by procedures to control process related uncertainty. Sample design and sizes based on analytical tests using conservative assumptions about contaminant distribution. Minimum sample size increased with 20 percent margin added. Precision of a particular measurement set can be gauged by performing regression analysis to assess the reproducibility of the measurement system results. The target data quality indicator for sets of paired data is: Regression correlation analysis (target r^2 approximately .75, SSE ≈ ± 10 percent)
Accuracy	Sampling and sample processing can introduce bias and affect Type I and Type II errors.	Field and laboratory sampling and measurement will be governed by procedures. The number of duplicates and blanks (Table 6–7) meet or exceed EPA guidance.

7.0 Instrumentation and Tools

To implement the Building 779 Cluster SAP, direct, static, surface contamination measurements on selected building surfaces will have to be made. In addition, smear samples to assess the removable surface contamination levels and surface media samples to assess the potential for total contamination embedded in surfaces and beneath paint will be collected and subsequently analyzed.

The instruments and special tools used to prepare these samples and make these measurements are described below.

7.1 Static Surface Contamination Measurements

7.1.1 The Eberline E-600 Multi-Purpose Radiation Survey Meter

Field measurement of surface contamination will be performed using the Eberline E-600 multi-purpose digital survey instrument (Figure 7–1). The E-600 accepts a variety of "Smart" probes as well as conventional GM, scintillation, and proportional detectors equipped with a "Smart Pack." It has a backlit liquid crystal display (LCD) with digital and simulated analog presentation. It has four operating modes including: 1) Rate meter, 2) Scaler, 3) Integrate, and 4) Peak Hold. In the "SCALER" mode, the instrument counts for a prescribed period of time (defined in the set-up and calibration of the probe) and reports the response in time normalized units. If the operator desires to measure a sample (in this case a surface) for a period of time either shorter or longer than the time programmed in the "SCALER" mode, the operator may select the "INTEGRATE" mode. In this mode the instrument continues counting until the operator suspends the count. The displayed response obtained using the "INTEGRATE" mode must be time normalized by the operator. The E-600 has an automatic background acquisition feature with a measure of precision about the background value. The instrument can be operated in "GROSS" mode or, once background has been acquired at the desired precision, can be operated in the "NET" mode in which background is subtracted from the displayed measurement. It is capable of data logging up to 500 data points in memory for subsequent download to a personal computer. It has three built-in channels which may be set up for pulse height analysis (alpha channel, beta channel, or alpha + beta channel) or may be used for three different calibration set-ups. The instrument provides a built-in speaker, both audible and visual alarms, a real time clock, a back lit, high contrast LCD display with alpha/numeric digital presentation and a simulated, linear analog meter display. In actuality, the instrument has only one "scale" in the traditional sense of analog meters, but has an analytical range and display capability over seven decades. A copy of the manufacturer's technical specifications are included at the end of this appendix for additional information on this instrument.

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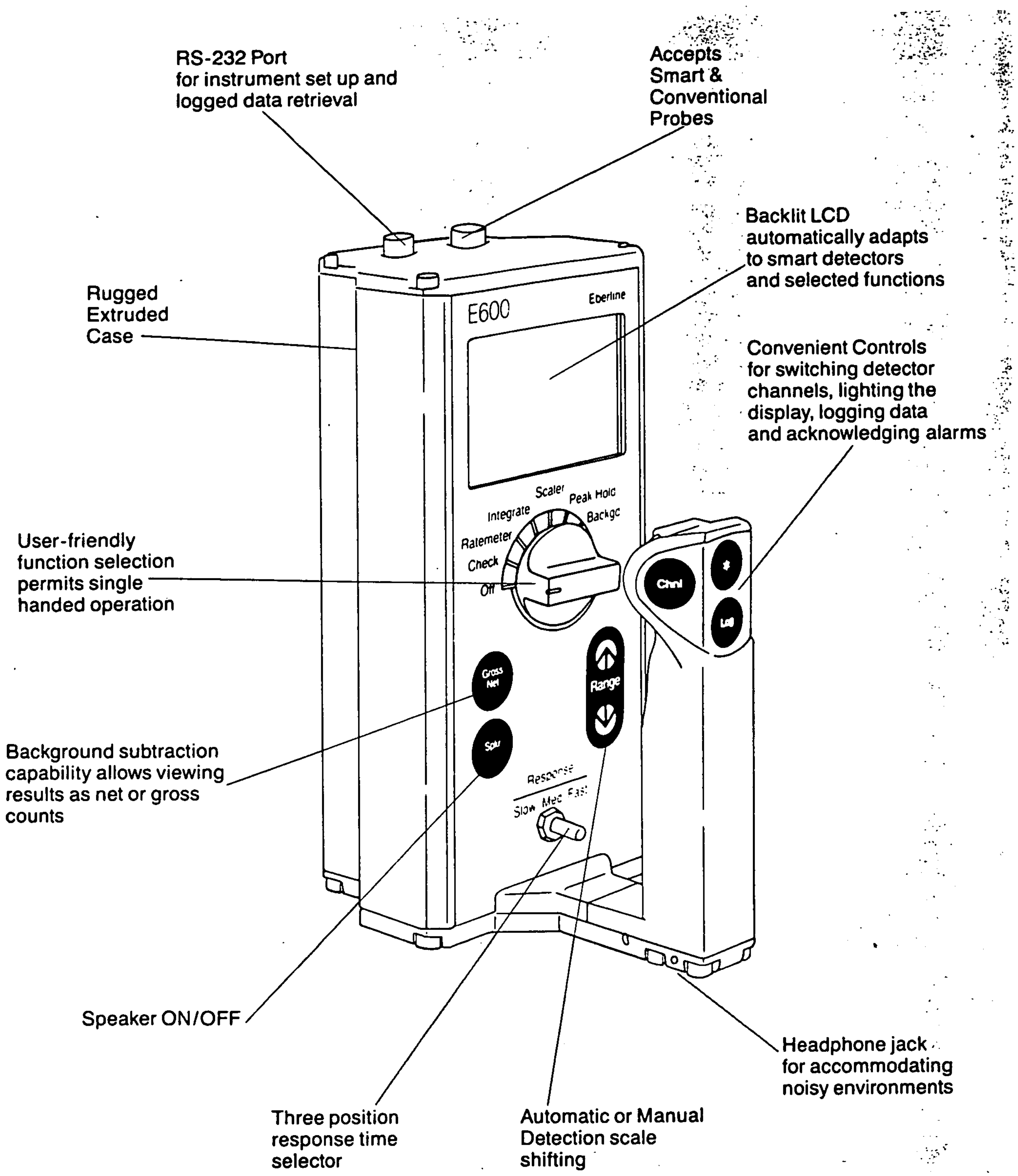

Figure 7–1. Eberline E600 Multi-Purpose Digital Survey Instrument

7.1.2 The Eberline HP-100 Gas Filled Proportional Detector Probe

The detector probe to be used for the static measurements of the building surfaces is a specially modified Eberline, model HP-100, large area (100 cm^2), gas-filled detector operating in the proportional region of the gas amplification curve (Figure 7–2). The detector has a large (100 cm^2), thin entrance window which allows alpha radiation and beta radiation of moderately low energy to be easily detected and measured.

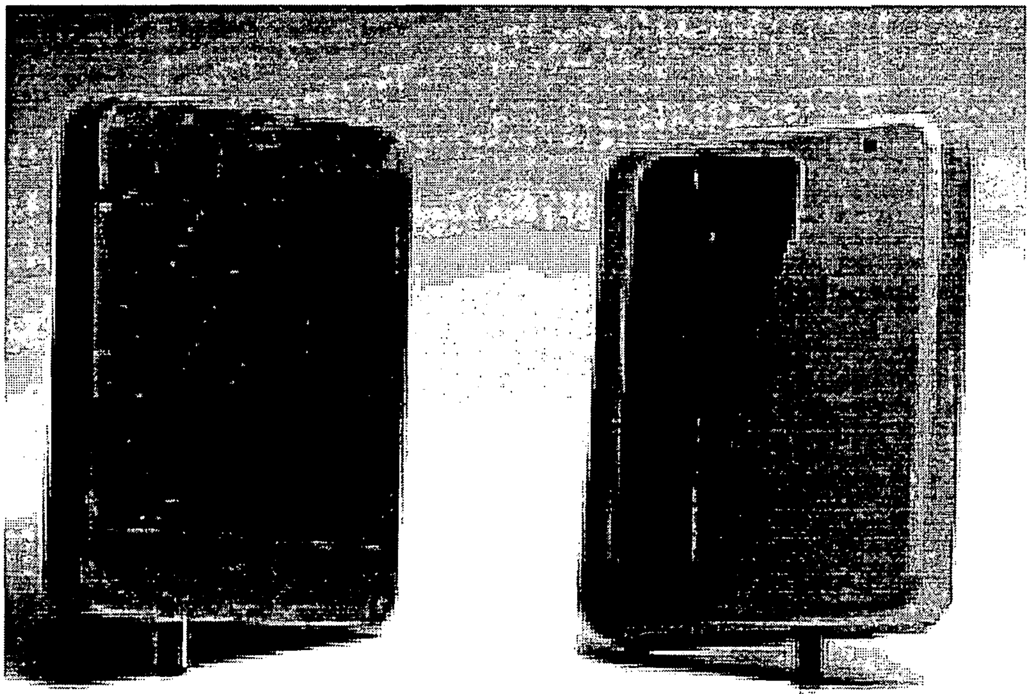

Figure 7–2. Eberline HP-100, Large Area Gas Proportional Detector

The probe has been physically modified to allow use of the probe without a continuous gas purge system. Sealed check valves with quick disconnect fittings (female portion) have been added to the inlet and outlet gas ports on the heel of the probe to permit a "charge" of fresh P-10 counting gas to be sealed in the active volume of the gas chamber.

The gas charge is established by inserting the other half (male portion) of the of the quick disconnect couplings into the gas ports on the HP-100. Once mated, the check valves are opened allowing fresh P-10 counting gas to flow through the gas chamber in the detector, purging depleted gas out. After one hour on a purge, the fresh gas charge is sealed by simply disconnecting the outlet and inlet gas port quick disconnect fittings.

The HP-100 is a conventional probe. That is, the probe is not equipped with a microchip which stores set point and calibration data necessary for use with the E-600 instruments. A simple addition of an in-line "smart pack" retrofits this conventional probe so that it stores set point data, calibration data, and communicates and operates with the E-600 survey instrument (Figure 7–3).

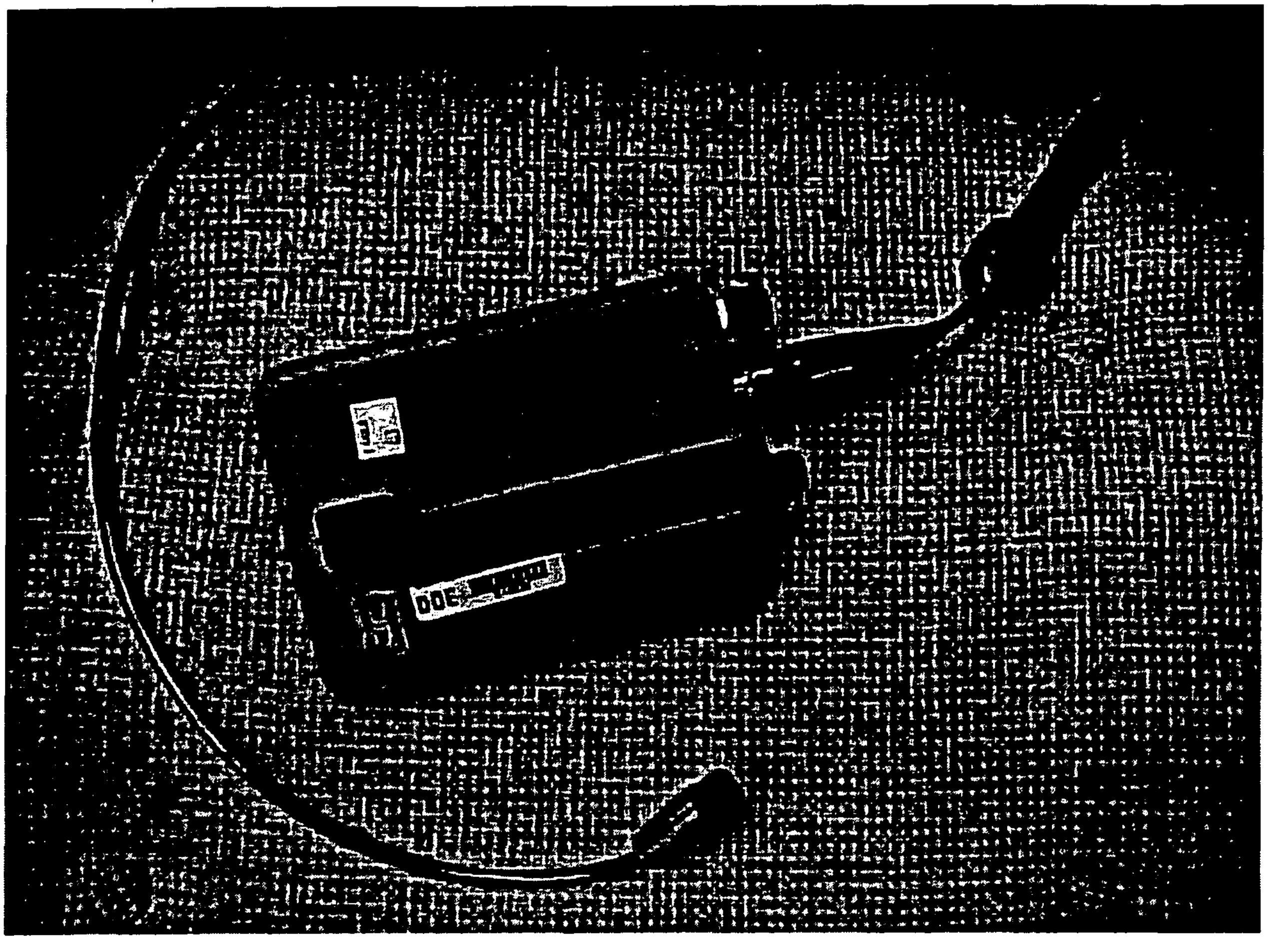

Figure 7–3. HP-100 Probe Shown With Check Valves and Smart Pack

To ensure that a consistent surface-to-detector geometry is achieved, an additional detector probe modification was made. Four “feet” were attached to the outer diameter surface of the probe face. These feet provide a ¼ inch standoff distance for the probe, consistently yielding the same geometry when the probe is placed onto the surface to be measured. The specially modified Eberline HP-100 probes are then calibrated with these modifications installed to ensure compensation for any radiometric variation resulting from the modifications.

As a gas proportional detector, the response of the HP-100 is energy dependent. However, because it is calibrated to the E-600 as a gross count rate measurement system, it is not energy compensated. That is, the instrument may over or under respond to radiation as the energy of the radiation incident on the detector's sensitive surface varies from the energy of radiation used to calibrate the detector. For this reason, it is critical that the calibration source be selected on the basis of it's alpha energy relative to the alpha energy of the contaminants of concern. For this application, Pu-239 was chosen as the calibration standard since it is a predominant nuclide in the specific activity of the transuranic mix expected in the buildings and because its alpha energy closely approximates the effective alpha energy spectrum presented by the transuranic series isotopes. The instrument nominally operates at a voltage of 1650 ± 150 VDC depending upon the altitude where the probe is calibrated and used. Dead time is nominally 10 μs. The face of the

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detector has a square opening of 10 cm by 10 cm (100 cm^2) covered by a mylar window with a thickness of 0.96 mg/cm^2. The operating temperature range is -22 to +140 °F (-30 to +60 °C). The probe is sensitive to both alpha and beta radiation. The stated typical efficiency (4π) for common isotopes and calibration standards are:

- ~ 26% for Pu-239 (alpha),
- ~ 36% for Sr/Y-90 (beta),
- ~ 31% for Cs-137 (beta),and
- ~ 29% for Tc-99 (beta).

7.1.3 Bar Code Scanner

To facilitate automatic recording of the measurement locations with the data recorded at that location, the E-600 will be equipped with a "3-9" bar code scanning pistol (Figure 7–4). The bar code scanner will permit the operator to electronically log all survey information needed to perform the statistical analysis and tests required to independently verify the Contractor's final status survey results. This has proven to be a significant tool for to avoiding human transcription errors and for resolving discrepancies in recorded data during the data analysis phase of the project. A unique, human-readable, bar code label will be affixed to the surface at each designated sample location. This bar code will serve as the master identification number for the sampling location. This is the bar code which will be scanned into the data memory of the E-600 following each static measurement. Samples collected from this location (smears and media samples) will have their own bar code number assigned but will be linked to the master identification number on the sample log.

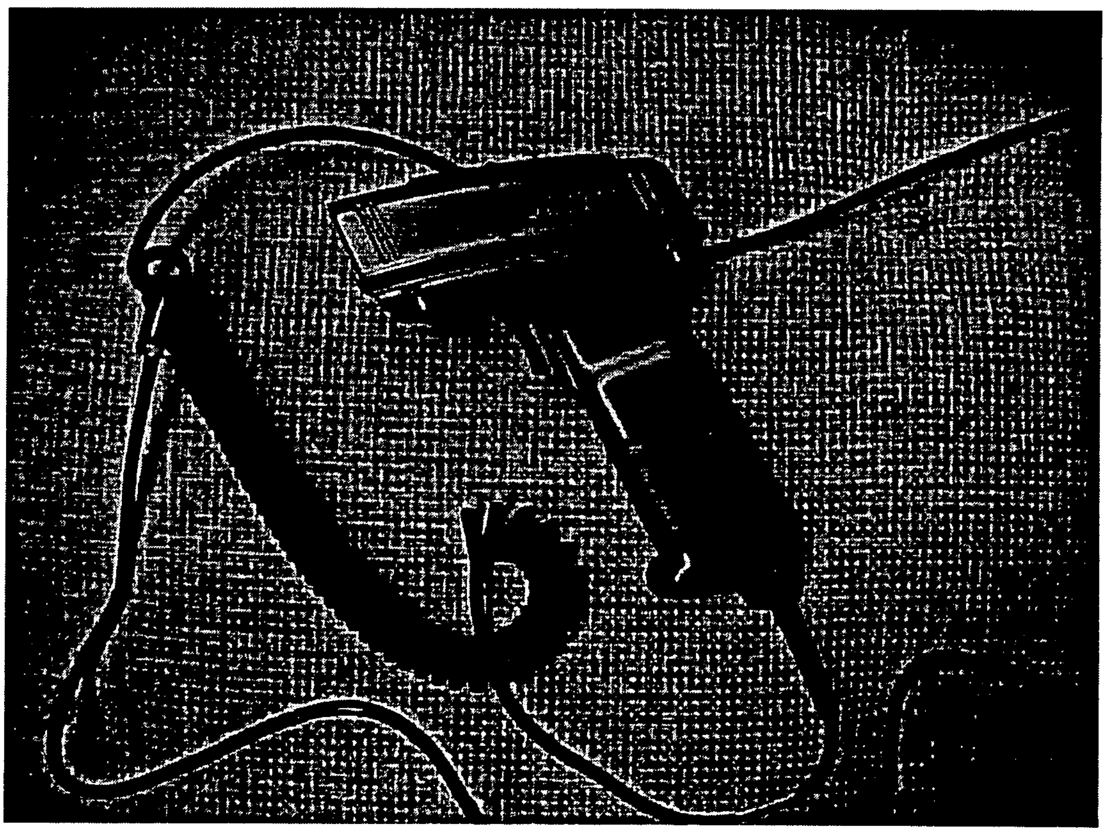

Figure 7–4.Bar Code Scanning Pistol

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7.2 Sample Collection

7.2.1 Smears

Removable surface contamination surveys made by collecting smear samples on the surface with a standard canvas material disc. Canvas has been selected to ensure that wipes are durable enough to withstand the rough surface textures expected without tearing or disintegrating. The discs will be 47 mm diameter circles, without any treatment or preparation. Each smear will be individually placed in an envelope and uniquely marked with a sample bar code. A group of smears will be packaged together in sealed plastic bags to prevent loss, damage, or contamination.

7.2.2 Media Sampling Tools

In order to adequately characterize the potential for contamination beneath and between layers of paint, and impregnated into porous surfaces, a veneer of surface material will be removed and sampled. Because the surfaces and substrates encountered are widely varied, no one sampling tool will satisfy the requirement to collect these surface media samples. It is desirable to obtain the smallest volume of surface media in the sample as is possible, while collecting all of the surface veneer to a depth which possibly contains the contaminants of concern. It is anticipated that a host of hand tools from chisels and hammers to scraper blades will be used. A flame-less heat gun may be used on some surfaces to liberate paint without incorporating substrate. Other locations, such as painted cinder block, require that the substrate surface be incorporated into the sample. For these locations, an electric rotary hammer drill with a special chiseling feature (no rotation) will be used. The tool will be equipped with a torque limiting device when used in a rotary mode to prevent operator injury. After the sample has been removed from the surface at the sample site, the sample will be packaged and labeled for subsequent analysis at the GJO Analytical Laboratory.

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Appendix A

Field Sampling Procedures

Department of Energy, Grand Junction Office

INDEPENDENT VERIFICATION PROGRAM
FIELD OPERATING PROCEDURE

PORTABLE RADIATION SURVEY INSTRUMENT RESPONSE CHECKS

IVP-RFETS-01
REVISION: July 20, 1999

EFFECTIVE DATE: *July 20, 1999*

APPROVED BY:

Technical Task Manager: Steve Rima / [signature] Date: 7/20/99
(Print and sign name)

IV Program Manager: Deb Richardson [signature] Date: 7/20/99
(Print and sign name) for MCB

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TABLE OF CONTENTS

1.0 INTRODUCTION

1.1 Purpose

This procedure provides instructions to personnel for the determination portable radiation instruments' response to an alpha, beta or gamma source. These checks are performed periodically to ensure stability of instrument operation between calibrations.

1.2 Scope

This procedure addresses the performance of response checks of field instruments used for measuring gross alpha and beta surface deposited radiological contamination where the contaminants of concern are alpha emitters.

1.3 Applicability

This procedure applies to portable radiation survey instruments used to perform radiological surface contamination field measurements in support of the MACTEC-ERS Independent Verification Program. It is not applicable to scalers or laboratory equipment used to make IV measurements.

1.4 Definitions

None

1.5 Responsibilities

1.5.1 IV Contractor Field Team Leader

The Field Team Leader is responsible to provide technical oversight and supervisory review functions for operations directed by this procedure.

1.5.2 IV Contractor Sample Team Personnel

Sample team personnel who will use an E-600 / HP-100 portable radiation survey instrument are responsible to perform and document portable radiation survey instrument response checks in accordance with this procedure and the requirements of the applicable Sampling and Analysis Plan.

2.0 PRECAUTIONS, LIMITATIONS AND NOTES

2.1 Precautions

[1] Handle sources in accordance with the RFETS Contractor's approved standard operating procedures.

[2] Use standard ALARA principles to minimize exposure.

2.2 Limitations

A. The source response ranges used for the Daily Source Checks are valid only at the location (site) where the After-Calibration Source Response was performed.

B. After-Calibration Source Response measurements performed using the Eberline, HP-100 gas filled proportional detector must be performed only after the probe has been purged with P-10 counting gas for at least one hour.

2.3 Notes

A. For analog meters, the instrument should be tested on each scale normally used (or expected to be used) in the performance of radiological surveys. For microprocessor based digital instruments (which do not have "scales") the instrument should be tested on at least one activity (preferably, over the activity range expected to be measured in the performance of radiological surveys).

B. The minimum activity above background that should be used to test a surface contamination survey instrument's response is that which results in approximately 200 counts over the counting time interval. Source activities below this value will not yield statistically valid variations within the ±20% acceptance criterion specified in the ANSI standard.

C. Sources to be used for general instrument types are listed in Appendix A, *Instruments and Applicable Check Sources.*

D. The after-calibration source response should be performed promptly upon receipt of an instrument following calibration or relocation from another site.

E. A new location or site for the purpose of this procedure means:
- a location with an altitude that varies by more than 1000 ft. from the altitude at which the after-calibration source response was previously determined, or
- a location where the same check source used to perform the after-calibration source response is not available to perform the daily instrument response check.

3.0 PREREQUISITE ACTIONS

[1] Verify that the instrument and probe have been calibrated within the past 12 months.

[a] Verify that the calibration is valid for the altitude at which it is to be used.

[2] Check the batteries to ensure that sufficient battery strength is available.

[3] Check the physical condition of the instrument to ensure that there is no obvious damage which might impact proper instrument response.

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4.0 FREQUENCIES

[1] Perform an After-Calibration Source Response (ACSR):

A. Before use in the field following calibration and gas purging for at least one hour,
B. If the instrument is moved to a new location (site), or
C. If a new source is to be used to perform Daily Response Checks.

[2] Perform Daily Response Checks:
A. Daily prior to instrument use,
B. Immediately after removing the HP-100 probe from a gas purge and prior to use,
C. Every two hours during use, and
D. Prior to replacing a HP-100 probe used to make field measurements on a gas purge.

NOTE *Daily Response Checks need not be performed when the instrument is not used.*

5.0 INSTRUMENT RESPONSE CHECKS

5.1 After-calibration Source Response (ACSR)

[1] Select the correct source (in accordance with Appendix A) for the type of instrument.

[2] Record the following information at the top of the *After-Calibration Source Response Check Data Sheet*, (GJO 1974e):
1. Location (site) (e.g., RFETS),
2. Date,
3. Instrument manufacturer, model#, seriel#,and government property number,
4. Probe manufacturer, model#, seriel#, and government property number,
5. Instrument and probe calibration due date, and
6. Radioactive check source identification number and isotope.

[3] Select the "SCALER" operating mode and choose a source-to-detector distance and geometry and any shielding necessary to obtain an instrument response at or near the desired activity. (See examples of detector/source configuration in Appendix B.)

[4] Record this information and the instrument response on Form GJO 1974e.

NOTE *Selection of a range is not necessary for microprocessor controlled or auto-ranging instruments. For these instruments, indicate "Auto-Ranging" in the blank for "Instrument Scale" column on Form GJO 1974e.*

[5] Expose the instrument to the selected source of radiation.

[6] Count the source for the programmed preset time (90 seconds),

[7] Record the indicted value.

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[8] Calculate the values 20% above and below the instrument response, AND record these values in the appropriate locations on Form GJO 1974e.

[9] Repeat steps **5.1 [1]** through **5.1 [8]** for each type of radiation.

5.2 Daily Instrument Response Check

[1] Obtain the same source used to perform the ACSR.

[2] Record the following information at the top of the *Independent Verification Instrument Response Check Data Sheet*, (Form IVP-1002):

1. Radioactive check source identification number and isotope,
2. Survey unit,
3. Instrument model number, and property number,
4. Probe model number, and property number,
5. Date

[3] Measure the instrument response for each type of radiation or range point to be used on the instrument, using the same source to detector distance, geometry, and shielding as listed on the form GJO 1974e.

[4] Manually record the instruments response on the *Independent Verification Instrument Response Check Data Sheet.*

[a] Record the time of each response check performed

[5] Log the result into the E-600 instrument's data logging memory.

[a] Press the **[LOG]** button one time. The instrument should "beep" indicating that the data logger is active.

[b] Scan the "Resp/Check" bar code. The instrument should "beep" again indicating that the data has been successfully logged into the instrument's memory.

[6] IF the instrument response falls within -20% and +20% of all the ACSR ranges, THEN,

[a] Check the ACCEPT / YES block on form IVP-1002,

[b] Initial the instrument response sticker for that day, and

[c] Release the instrument for use.

[7] IF the instrument response is outside any of the -20% to +20% ranges, THEN,

[a] Check the ACCEPT / NO block on form IVP-1002,

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[b] Annotate the deficiency in the comment section of form IVP-1002,

[c] Notify the Sampling Field Team Leader of the discrepancy,

[d] Forward the ACSR Data Sheet and the *Independent Verification Instrument Response Check Data Sheet(s)* to the Field Team Leader for review,

[e] Tag the instrument as "defective,"

[f] Remove the instrument from service, and

[g] Return the instrument for repair or re-calibration.

[8] Repeat steps **5.2 [1]** through **5.2 [6]** for each type of radiation.

5.3 Establishing After Calibration Response Data Following Instrument Transfer

[1] **IF** an instrument is to be transferred to a new location, (such that the source used to establish the ACSR will not be available to perform subsequent daily response checks) **THEN**

[a] Perform the daily instrument response check in accordance with section **5.2** using the already established ACSR.

[b] Verify that the instrument's response is acceptable prior to relocating the instrument,

[c] Perform a new ACSR at the new location (or with the new source) in accordance with section **5.1**.

6.0 RECORDS

6.1 Records Generated by this Procedure

A. *After-Calibration Source Response Check Data Sheet* (GJO 1974e)

B. *Independent Verification Instrument Response Check Data Sheet* (IVP-1002)

6.2 Record Review

[1] Review the completed documentation to ensure completeness, accuracy, legibility, and reproducibility.

1. IV Contractor records shall conform with the MACTEC-ERS General Administrative Procedures Manual (MAC-1000), Section 3.0, "Records Management Procedure."

[2] Compare the data recorded with specified limits and procedural controls to determine if trends are developing or unexpected results were obtained.

[a] Notify the Field Team Leader of any trends or unexpected results.

[3] Record the applicable File Index Number on each record generated by this procedure.

6.3 Record Disposition

[1] Maintain the documentation generated by this procedure as S-level quality records.

[2] Transmit completed and reviewed records generated by this procedure to the IVP records custodian for storage and maintenance in accordance with the applicable records management plan and Working File Index.

1. IV contractor records shall be managed in accordance with the records management procedure provided in the MACTEC-ERS *General Administrative Procedures Manual* (MAC1000) and the applicable project records Working File Index.

7.0 REFERENCES

A. ANSI N323 - 1978, *Radiation Protection Instrumentation Test and Calibration*

B. Z000100, *Independent Verification Sampling and Analysis Plan for Building 779 Cluster,"*

8.0 FORMS AND APPENDICES

8.1 Forms

A. After-Calibration Source Response Check Data Sheet (GJO 1974e)

B. *Independent Verification Instrument Response Check Data Sheet* (IVP-1002)

8.2 Appendices

A. "Instruments and Applicable Check Sources"

B. Example of "Daily Instrument Response Check Sticker"

C. "After-Calibration Source Response Check Data Sheet," (GJO 1974e)

D. "Independent Verification Instrument Response Check Data Sheet," (IVP-1002)

Appendix A
Instruments and Applicable Check Sources
Page 1 of 1

Source	*Instruments*
Cl-36	Contamination Rate meters with β probes
Pu-239	Contamination Rate meters with α probes

NOTE *Sources not listed above shall be approved for use by the project Health Physicist.*

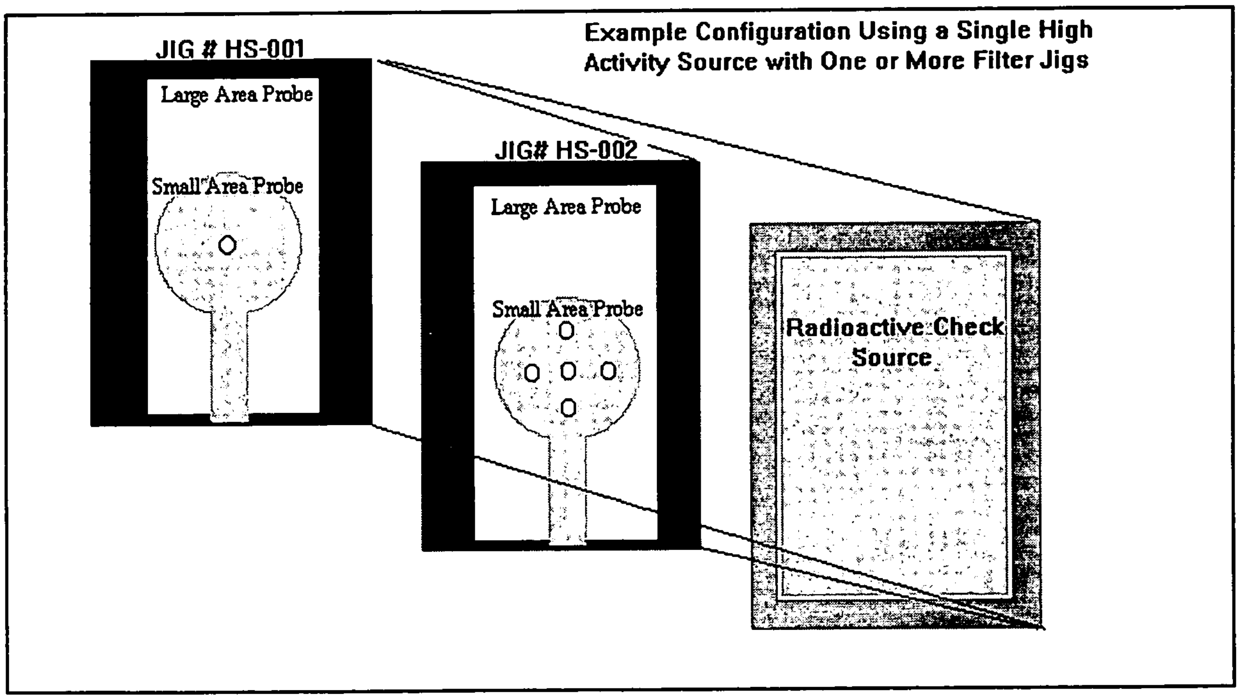

Figure 1 Alpha and Beta/Gamma Surface Contamination Instrument Source Response Diagram

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Appendix B
Example of an Instrument Response Check Sticker
Page 1 of 1

Instrument Response			
Type: ______			
S/N: ______			
Month: ______			
Day	**Initial**	**Day**	**Initial**
1		17	
2		18	
3		19	
4		20	
5		21	
6		22	
7		23	
8		24	
9		25	
10		26	
11		27	
12		28	
13		29	
14		30	
15		31	
16			

Appendix C
"After-Calibration Source Response Check Data Sheet," (GJO 1974e)
Page 1 of 1

After-Calibration Source Response Check Data Sheet

Location ______________________

Month __________ Day __________ Year __________

Survey Instrument Data

Manufacturer ______________________

Model No. ______________________

Government Property No. ______________________

Calibration Due Date ______________________

Detector/Probe Data *(if applicable)*

Manufacturer ______________________

Model No. ______________________

Government Property No. ______________________

Calibration Due Date ______________________

Check Source Data

Isotope ______________________

Source I.D. No. ______________________

Instrument Scale	Source Detector Distance	Shielding/Geometry	Instrument Response	-20%	+20%	Scale Units

Comments:

____

____

____

____

____

____

____

Performed by (print)	*Performed by (signature)*	*Date*
Reviewed by (print)	*Reviewed by (signature)*	*Date*

File Index No. ________

GJO 1974e
11/98

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Appendix D
"Independent Verification Instrument Response Check Data Sheet" (IVP-1002)
Page 1 of 1

INDEPENDENT VERIFICATION INSTRUMENT RESPONSE CHECK DATA SHEET

Survey Location: RFETS, 779 Cluster / Building ______ Survey Unit: ______ Date: ______

Instrument Model Number: Eberline, E 600 ______ Instrument ID Number: ______ Calibration Expires: ______

Detector Probe Type: Eberline, HP-100 ______ Operator Name: ______ Signature: ______

Sample ID No. (Affix or Record Bar Code)	Time	Measurement Type	Static Count Time (minutes)	HP-100 Probe ID#	GROSS Instrument Reading (dpm/100 cm^2)	Accept		Comments (Include reason for response check measurement)
						YES	NO	
		Direct Static Measurement Response Check	1.5 Minute					
		Direct Static Measurement Response Check	1.5 Minute					
		Direct Static Measurement Response Check	1.5 Minute					
		Direct Static Measurement Response Check	1.5 Minute					
		Direct Static Measurement Response Check	1.5 Minute					
		Direct Static Measurement Response Check	1.5 Minute					
		Direct Static Measurement Response Check	1.5 Minute					

Form IVP-1002, July 1999

Supervisory Review: ______ / ______ / ______
Print Name Signature Date

File Index Number ______

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Department of Energy, Grand Junction Office

INDEPENDENT VERIFICATION PROGRAM
FIELD OPERATING PROCEDURE

INSTRUMENT BACKGROUND DETERMINATION

IVP-RFETS-02
REVISION: July 20, 1999

EFFECTIVE DATE: *July 20, 1999*

APPROVED BY:

Technical Task Manager: Steve Rima / [signature] Date: 7/20/99
(Print and sign name)

IV Program Manager: Deb Richardson [signature] for MCB Date: 7/20/99
(Print and sign name)

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1.0 INTRODUCTION

1.1 Purpose

This procedure provides instruction to personnel for the determination of portable radiation survey instrument background. Instrument background is affected by electronic noise inherent in the instrument as well as instrument sensitivity to radiation from sources other than the contaminant of concern in the environment.

1.2 Scope

This procedure addresses the performance of instrument background measurements as a prerequisite to using portable radiation survey instruments.

1.3 Applicability

This procedure is applicable to IVC personnel performing instrument background determination for the E-600 / HP-100 portable radiation survey.

1.4 Definitions

Instrument Background — Is the response of the radiation detecting instrument to sources of radiation in the environment such as cosmic radiation and to electronic noise in the instrumentation which may produce a measurable signal not due to radiation. It does not include the instrument's response to concentrations of radioactive materials which might be present in the media being measured but which are considered to be part of the background environment.

1.5 Responsibilities

1.5.1 IV Contractor Field Team Leader

The Field Team Leader is responsible to provide technical oversight and supervisory review functions for operations directed by this procedure.

1.5.2 IV Contractor Sample Team Personnel

Sample team personnel who will use an E-600 / HP-100 portable radiation survey instrument are responsible to perform instrument background determinations in the immediate vicinity of the survey unit being surveyed at the following frequencies:

A. At the beginning of each sampling shift,
B. At the beginning of sampling on each individual survey unit,
C. After switching HP-100 probes,
D. Every two hours during each sampling shift,
E. At the conclusion of each sampling shift, and
F. At the conclusion of direct measurement sampling in each survey unit.

2.0 PRECAUTIONS, LIMITATIONS AND NOTES

2.1 Precautions

None

2.2 Limitations

A. The surface on which the background measurements will be made must be free of residual radioactivity.

B. Eberline® model HP-100 gas-filled proportional detector probes must be purged with fresh P-10 counting gas at least every three hours, and for a period of at least 1 hour prior to using the detector to make measurements, including background measurements.

2.3 Notes

A. "Smart" survey instruments are programmed to automatically report results normalized to dpm/100 cm^2. In this case, efficiency and area correction factors are automatically applied. Area correction factors for instruments which report results in units of counts or counts per minute (cpm) are tabulated in Appendix B.

B. The determination of background as prescribed in this procedure is the instrument background. Instrument background is affected by electronic noise inherent in the instrument as well as instrument sensitivity to radiation from sources other than the contaminant of concern in the environment. For the purposes of this SAP, it is assumed that the concentration of the contaminants of concern are not present in the environment as contributors to the measured signal as background.

C. When performing alpha contamination surveys only, it is not necessary to collect instrument background measurements for the beta channel even if the instrument is capable of beta contamination detection.

3.0 PREREQUISITE ACTIONS

A. Setup a surface (a table, workbench, etc.) that is known not to be impacted or potentially contaminated with radioactive material, in the immediate area of the survey unit being independently verified.

B. Verify that the instrument and probe have been calibrated within the past 12 months.

C. Verify that the probe selected has been purged with fresh P-10 counting gas for at least one hour.

D. Verify that the instrument is response checked after each counting gas purge period prior to use.

E. Check the instrument battery and physical condition of the instrument train to ensure that all elements of the sampling train are in place.

4.0 DETERMINING INSTRUMENT BACKGROUND

[1] Turn the instrument on and select the appropriate channel α or β.

[a] Select "SLOW" response time.

[b] Select the "GROSS" data display mode.

[2] Select the instrument's SCALER Count mode.

[3] Place the probe on the "background" surface.

[a] Hold the probe steady and parallel to the plane of the surface being measured.

[4] Press the **[*]** button to activate the instrument in the "SCALER" mode.

NOTE *The instrument scaler count time is pre-programmed into the instrument set points during calibration. The required (1.5 minute) count time should be pre-programmed and displayed in the instruments display window when the scaler count is initiated.*

[a] **IF** the scaler count time is not set to the required count time,
THEN remove the instrument from service and have the scaler count time reset.

[5] Record the following information on the *Independent Verification Instrument Background Data Sheet*:

1. Radioactive check source identification number and isotope,
2. Instrument scale units,
3. Instrument model number, and property number,
4. Probe model number, and property number,
5. Date and time.

[6] Acquire a 1.5 minute count. The instrument will "beep" indicating that the programmed count time has elapsed and that the scaler counting has been completed.

[7] Manually record the result on the *Independent Verification Instrument Background Data Sheet.*

[8] Log the result into the E-600 instrument's data logging memory.

[a] Press the **[LOG]** button one time. The instrument should "beep" indicating that the data logger is active.

[b] Scan the "Background" bar code. The instrument should "beep" again indicating that the data has been successfully logged into the instrument's memory.

[9] Record the background result and time acquired on the *Independent Verification Instrument Background Data Sheet.*

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[10] Repeat steps **[1]** through **[8]** for each instrument channel for which a background measurement is required.

NOTE *The alpha channel background should be less than 22 dpm/100 cm^2. The beta channel background should be less than 500 dpm/100 cm^2.*

[11] **IF** the alpha channel background is greater than 22 dpm/100 cm^2,
OR the beta channel background is greater than 500 dpm/100 cm^2,
THEN report the finding to the IV Field Team Leader.

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5.0 RECORDS

5.1 Records Generated by This Procedure

A. "*Independent Verification Instrument Background Data Sheet*", Form IVP 1001.

5.2 Supervisory Review

[1] Review the completed documentation to ensure completeness, accuracy, legibility, and reproducibility.

1. IV Contractor records shall conform with the MACTEC-ERS *General Administrative Procedures Manual* (MAC-1000), Section 3.0, "Records Management Procedure."

[2] Compare the data recorded with specified limits and procedural controls to determine if trends are developing or unexpected results were obtained.

[3] Notify the Sampling Field Team Leader of any trends or unexpected results.

[4] Record the applicable File Index Number in the bottom right hand corner of each record generated by this procedure.

5.3 Record Disposition

[1] Maintain the documentation generated by this procedure as S-level quality records.

[2] Transmit completed and reviewed records generated by this procedure to the IVP records custodian for storage and maintenance in accordance with the applicable records management plan and Working File Index.

1. IV Contractor records shall be managed in accordance with the records management procedure provided in the MACTEC-ERS *General Administrative Procedures Manual* (MAC 1000) and the applicable project records Working File Index.

6.0 REFERENCES

A. Z000100, *"Independent Verification Sampling and Analysis Plan for Building 779 Cluster"*

7.0 FORMS AND APPENDICES

7.1 Forms

A. "*Independent Verification Instrument Background Data Sheet*", Form IVP 1001

7.2 Appendices

A. "*Independent Verification Instrument Background Data Sheet*", Form IVP 1001

Appendix A
"Independent Verification Instrument Background Data Sheet", Form IVP 1001
Page 1 of 1

INDEPENDENT VERIFICATION INSTRUMENT BACKGROUND DATA SHEET

Survey Location: RFETS, 779 Cluster / Building   Survey Unit: ________   Date: ________

Instrument Model Number: Eberline, E 600   Instrument ID Number: ________   Calibration Expires: ________

Detector Probe Type: Eberline, HP-100   Operator Name: ________   Signature: ________

Sample IDNo. (Affix or Record Background Bar Code)	Time	Measurement Type	Static Count Time (minutes)	HP-100 Probe ID#	GROSS Instrument Reading (dpm/100 cm^2)	Comments (include reason for background measurement)
		Direct Static Background Measurement	1.5 Minute			
		Direct Static Background Measurement	1.5 Minute			
		Direct Static Background Measurement	1.5 Minute			
		Direct Static Background Measurement	1.5 Minute			
		Direct Static Background Measurement	1.5 Minute			
		Direct Static Background Measurement	1.5 Minute			
		Direct Static Background Measurement	1.5 Minute			

Form IVP-1001, July 1999

Supervisory Review: ________ / ________ / ________
Print Name / Signature / Date

File Index Number ________

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Department of Energy, Grand Junction Office

INDEPENDENT VERIFICATION PROGRAM
FIELD OPERATING PROCEDURE

RADIOLOGICAL SURFACE CONTAMINATION SURVEYS

IVP-RFETS-03
REVISION: July 20, 1999

EFFECTIVE DATE: *July 20, 1999*

APPROVED BY:

Technical Task Manager: Steve Rima / [signature] Date: 7/20/99
(Print and sign name)

IV Program Manager: Deb Richardson [signature] Date: 7/20/99
(Print and sign name) for MCB

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1.0 INTRODUCTION

1.1 Purpose

This procedure provides instruction to personnel for the performance of direct measurement surveys of radiological surface contamination.

1.2 Scope

This procedure addresses the performance of *in situ* field measurements for gross alpha and beta surface deposited radiological contamination using portable radiation survey instruments.

1.3 Applicability

This procedure is applicable to radiological surface contamination surveys performed in support of the independent verification of buildings and surfaces undergoing decontamination and decommissioning.

1.4 Definitions

A. *in situ* — Measurements made without collecting a sample or removing the contaminant from its existing environment.

1.5 Responsibilities

1.5.1 IV Contractor Field Team Leader

The Field Team Leader is responsible to provide technical oversight and supervisory review functions for operations directed by this procedure.

1.5.2 IV Contractor Sample Team Personnel

Sample team personnel who will use an E-600 / HP-100 portable radiation survey instrument are responsible to perform and document radiological surface contamination surveys in accordance with this procedure and the requirements of the applicable Sampling and Analysis Plan.

2.0 PRECAUTIONS, LIMITATIONS AND NOTES

2.1 Precautions

A. Compressed cylinders of P-10 counting gas must be used in the upright position, secured in place, and transported with the cylinder valve guard in place.

B. Always shut purge gas system isolation valves and vent isolated sections of the system before connecting or disconnecting the purge manifold.

C. The mylar window over the active face of the HP-100 detector probe is extremely thin and fragile. Always protect the face when the probe is not in use to prevent instrument damage.

D. Use caution to prevent over pressurizing the detector and rupturing the window.

2.2 Limitations

A. Independent verification surveys using the Direct Static Measurement protocol described in this procedure should not be performed if the instrument background rate is greater than the maximum instrument background specified in the Sampling and Analysis Plan.

B. Eberline® model HP-100 gas-filled proportional detector probes must be purged with fresh P-10 counting gas at least every three hours, and for a period of at least 1 hour prior to re-use in the field.

C. For sample locations where both removable and total surface contamination measurements are specified, the total surface contamination measurement should be performed prior to wiping the surface to perform the removable contamination sampling procedure.

2.3 Notes

A. "Smart" survey instruments like the HP-100 are programmed to automatically report results normalized to dpm/100 cm^2. In this case, efficiency and area correction factors are automatically applied. An area correction factor of 1.0 is used for the HP-100 probe.

B. The following minimum information is required for all contamination surveys:

1. Date and time,
2. Purpose (Independent Verification),
3. General and specific location (e.g., Site, Building, Survey Unit #),
4. Name and signature of the surveyor,
5. Reference to an associated SAP,
6. Instrument and detector serial numbers,
7. Correction factors (e.g., efficiency, probe area, surface attenuation, etc.),
8. Counting time (if scaler or time integration counting is used),
9. The isotopes present or suspected,
10. Survey method (i.e., Direct Static Measurement),
11. Unique sample identification number (or measurement location number),
12. Amount of measured contamination present (including units), and
13. Pertinent information needed to interpret results

C. Eberline® model HP-100 gas-filled proportional detector probes are designed to operate as gas flow detectors. The probes are modified (Eberline standard modification) to permit use as a sealed volume gas-filled detector. The modified probes have been field tested and shown to be stable (hold a sufficient gas charge) for 4 to 6 hours before needing to be purged and recharged with fresh counting gas.

3.0 PREREQUISITE ACTIONS

[1] Ensure ambient noise level is low enough to enable the technician to hear the audible signal from the count rate meter, either from the built-in speaker or using headphones.

[2] Ensure that the surfaces to be measured are dry.

[3] Select an E-600 meter and HP-100 probe.

[4] Verify that the probe selected has been purged with fresh P-10 counting gas for at least one hour.

NOTE *Pre-operational checks are required to be performed daily prior to use, when a freshly purged probe is placed in service, and after two hours of field use before the probe is purged to document that the instrument is performing as expected.*

[5] Verify that the required pre-operational checks have been performed on the portable radiation survey instrument to be used. (See procedure IVP-RFETS-01, "Portable Radiation Survey Instrument Response Checks")

[6] Verify that the required instrument background determinations have been performed with the portable radiation survey instrument to be used. (See procedure IVP-RFETS-02, "Instrument Background Determination")

4.0 DIRECT STATIC MEASUREMENTS

[1] Locate the designated sample location.

[2] Select the instrument's "SCALER" operating mode.

[3] Select "SLOW" response time.

[4] Select the "GROSS" data display mode.

[5] Place the detector probe onto the surface until the alignment standoff feet rest against the surface to be measured.

[a] Hold the probe steady and parallel to the plane of the surface being measured.

[6] Press the [✻] button to activate the instrument in the "SCALER" mode.

NOTE *The instrument scaler count time is pre-programmed into the instrument set points during calibration. The required (1.5 minute) count time should be pre-programmed and displayed in the instruments display window when the scaler count is initiated.*

[a] <u>IF</u> the scaler count time is not set to the required count time,
<u>THEN</u> remove the instrument from service and have the scaler count time reset.

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[7] Acquire a 1.5 minute count. The instrument will "beep" indicating that the programmed count time has elapsed and that the scaler counting has been completed.

[8] Manually record the result, date, and time on the Independent Verification Survey Data Sheet

[9] Log the result into the E-600 instrument's data logging memory.

[a] Press the [LOG] button one time. The instrument should "beep" indicating that the data logger is active.

[b] Scan the associated sample location bar code. The instrument should "beep" again indicating that the data has been successfully logged into the instrument's memory.

[10] **IF** the result is less than 300 dpm/100 cm^2,
THEN proceed to the next designated sample location.

[11] **IF** the result is greater than 300 dpm/100 cm^2,
THEN

[a] Uniquely identify the sample location,
[b] Immediately notify the IVC Sampling Field Team Leader,
[c] Have the IVC Sampling Field Team Leader notify the Contractor's Final Staus Survey Radiological Engineer
[d] Await direction from the IVC Sampling Field Team Leader before proceeding to the next designated sample location.

[12] Record any pertinent or characteristic observations regarding the nature of the surface.

5.0 RECORDS

5.1 Records Generated by This Procedure

A. "*Independent Verification Survey Data Sheet*", Form IVP 1000.

5.2 Supervisory Review

[1] Review the completed documentation to ensure completeness, accuracy, legibility, and reproducibility.

1. IV Contractor records shall conform with the MACTEC-ERS *General Administrative Procedures Manual* (MAC-1000), Section 3.0, "Records Management Procedure."

[2] Compare the data recorded with specified limits and procedural controls to determine if trends are developing or unexpected results were obtained.

[3] Notify the sampling Field Team Leader of any trends or unexpected results.

[4] Record the applicable File Index Number in the bottom right hand corner of each record generated by this procedure.

5.3 Record Disposition

[1] Maintain the documentation generated by this procedure as S-level quality records.

[2] Transmit completed and reviewed records generated by this procedure to the IVP records custodian for storage and maintenance in accordance with the applicable records management plan and Working File Index.

1. IV Contractor records shall be managed in accordance with the records management procedure provided in the MACTEC-ERS *General Administrative Procedures Manual* (MAC 1000) and the applicable project records Working File Index.

6.0 REFERENCES

A. Z000100, *"Independent Verification Sampling and Analysis Plan for Building 779 Cluster"*

B. NUREG 1507, *"Minimum Detectable Concentrations with Typical Radiation Survey Instruments for Various Contaminants and Field Conditions"*

C. 10 CFR 835, *"Occupational Radiation Protection"*

D. DOE/EH-0256T, *"DOE Radiological Control Manual"*

E. DOE Order 5400.5, *"Radiation Protection of the Public and the Environment."*

F. *"E-600 Portable Radiation Monitor Technical Manual,"* Eberline Instruments, Corp.

7.0 FORMS AND APPENDICES

7.1 Forms

A. "*Independent Verification Survey Data Sheet*", Form IVP 1000.

7.2 Appendices

A. "Surface Contamination Guidelines for Various Isotopes"

B. "*Independent Verification Survey Data Sheet*", Form IVP 1000.

Appendix A
Surface Contamination Guidelines for Various Isotopes
Page 1of 1

Survey Method [3]	Isotopes [1]	Average [2] [3] dpm/100 cm^2	Maximum [2] [4] dpm/100 cm^2	Removable [2] [5] dpm/100 cm^2
TRU Alpha	Transuranics, Ra-226, Ac-227, Ra-228, Th-228, Th-230, Pa-231	100 alpha	300 alpha	20 alpha
Uranium Alpha	U-Natural, U-235, U-238, and associated decay product, alpha emitters	5,000 alpha	15,000 alpha	1,000 alpha
Low Energy Beta	H-3 and other beta emitters with E-max < 0.15 MeV	NA	NA	1,000 beta
All Other Beta	Beta-gamma emitters (radionuclides with decay modes other than alpha emission or spontaneous fission) except Sr-90 and other noted above. [6]	5,000 beta	15,000 beta	1,000 beta

(1) The values in this table apply to radioactive contamination deposited on, but not incorporated into the interior of the contaminated item.

(2) As used in this table, dpm (disintegrations per minute) means the rate of emission by radioactive material as determined by correcting the counts per minute measured by an appropriate detector for background, efficiency, and geometric factors associated with the instrumentation.

(3) Where surface contamination by both alpha-and beta-gamma-emitting radionuclides exists, the limits established for alpha- and beta-gamma-emitting radionuclides apply independently.

(4) The levels may be averaged over 1 square meter provided the maximum activity in any area of 100 cm^2 is less than three times the allowable average values.

(5) The amount of removable radioactive material per 100 cm^2 of surface area should be determined by swiping the area with dry filter paper or soft absorbent paper while applying moderate pressure and the assessing the amount of radioactive material on the swipe with an appropriate instrument of know efficiency (See Field Operating Procedure IVP-RFETS-04).

(6) This category of radionuclides includes mixed fission products, including the Sr-90 which is present in them. It does not apply to Sr-90 which has been separated from the other fission products or mixtures where the Sr-90 has been enriched.

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Appendix B
"Independent Verification Survey Data Sheet", Form IVP 1000.
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INDEPENDENT VERIFICATION SURVEY DATA SHEET

Survey Location: RFETS, 779 Cluster / Building ____ Survey Unit: ____ Date: ____

Instrument Model Number: Eberline, E 600 ____ Instrument ID Number: ____ Calibration Expires: ____

Detector Probe Type: Eberline, HP-100 ____ Operator Name: ____ Signature: ____

Sample Location# or Sample ID# (Affix or record Bar Code #)	Time	Sample or Measurement Type	HP-100 Probe ID Number:	Static Count Time	GROSS Instrument Reading (dpm/100 cm²)	Comments (Include description of surface characteristics and media composition as applicable)

Form IVP-1000, July 1999

Supervisory Review: ____ / ____ / ____ File Index Number ____
Print Name Signature Date

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Department of Energy, Grand Junction Office

INDEPENDENT VERIFICATION PROGRAM
FIELD OPERATING PROCEDURE

SURFACE SAMPLING to DETERMINE RADIOLOGICAL SURFACE CONTAMINATION

IVP-RFETS-04
REVISION: July 20, 1999

EFFECTIVE DATE: *July 20, 1999*

APPROVED BY:

Technical Task Manager: Steve Rima / [signature] Date: 7/20/99
(Print and sign name)

IV Program Manager: Deb Richardson [signature] Date: 7/20/99
(Print and sign name) for MCB

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1.0 INTRODUCTION

1.1 Purpose

This procedure provides instruction to personnel for the collection of samples to assess removable and fixed radiological contamination on surfaces.

1.2 Scope

This procedure addresses the collection of samples in the field for subsequent measurement to determine the amount of surface deposited radiological contamination using smears and destructive sampling of the surface through removal of the surface veneer media.

1.3 Applicability

This procedure is applicable to the collection of samples used to assess residual radiological surface contamination in support of the independent verification of buildings and surfaces undergoing decontamination and decommissioning.

1.4 Definitions

A. *Smear* — A sample collected by wiping the surface of the sample location with a semi-absorbent sample media disc which is clean and dry while applying moderate pressure to transfer removable radioactivity from the surface to the sample media. The smear sample is then assessed by measuring the amount of radioactive material on the smear sample disc.

1.5 Responsibilities

1.5.1 IV Contractor Field Team Leader

The Field Team Leader is responsible to provide technical oversight and supervisory review functions for operations directed by this procedure.

1.5.2 IV Contractor Sample Team Personnel

Sample team personnel who will collect samples of surfaces are responsible to perform and document the sample collection and to maintain sample integrity in accordance with this procedure and the requirements of the applicable Sampling and Analysis Plan.

2.0 PRECAUTIONS, LIMITATIONS AND NOTES

2.1 Precautions

A. Operators should wear heat resistant gloves while operating a heat gun to sample surfaces.

B. When using a heat gun, a portable fire extinguisher should be readily available in the room or area where it is used.

[10] Repeat step **4.0 [1]** through **4.0 [9]** as necessary to obtain the required number of samples indicated for the survey unit in the SAP.

[11] Record all associated survey data on the *"Independent Verification Survey Data Sheet,"* form IVP 1000.

[12] Catalog each smear sample on a *"Chain of Sample Custody,"* form GJO 1512.

[13] Submit the smear samples for "Gross Alpha Activity" analysis.

5.0 COLLECTION OF SURFACE MEDIA SAMPLES

[1] Don a clean disposable glove(s) to handle sampling tools and collect surface media samples to prevent possible sample cross-contamination.

[2] Layout and mark the surface to be sampled.

[a] Mark an area of 100 cm^2 (10 x 10 cm) with a scribe or marker.

[3] Place a sample catch device under the sample location such that all surface media removed will be collected.

[4] Select the sampling tool(s) that will most effectively remove the surface veneer while minimizing the amount of substrate material removed.

[5] Remove the paint (or other surface material) from within the marked out 100 cm^2 area on the surface to be sampled.

[6] Place the entire surface media sample collected into a sealable plastic sample container.

[a] Seal the sample container.

[7] Decontaminate reusable sampling equipment.

[a] Wipe down the sampling equipment with a cloth or paper wipe.

[b] Lightly spray the surface of the equipment with a mister (sprayer) filled with a mild decontamination solution.

[c] Wipe all surfaces with a clean disposable wipe.

[d] Dispose of the wipe.

[e] Lightly spray the surface of the equipment with a mister (sprayer) filled with a mild decontamination solution.

[f] Wipe all surfaces with a clean disposable wipe.

[g] Dispose of the wipe.

[8] Remove the disposable glove(s) worn to collect the surface media sample and decontaminate the sampling equipment.

[a] Discard the glove(s) as sample waste.

[9] Affix a unique sample bar code label to the outside of the sample container.

[10] Place the individual sample container into a sealable secondary container large enough to hold several samples (10 to 40 samples).

[a] Label the outside of the secondary container with the Building number and survey unit ID number from which the surface media samples were collected.

[11] Affix a duplicate sample bar code (or record the smear sample bar code number) on the Independent Verification Survey Data Sheet, from IVP-1000

[a] Place the label in the row corresponding to the sample location from which the sample was collected.

[12] Record the time the surface media sample was collected.

[13] Record any comments pertinent to the description or characteristics of the surface sampled.

[14] Repeat step **5.0 [1]** through **5.0 [13]** as necessary to obtain the required number of samples indicated for the survey unit in the SAP.

[15] Record all associated survey data on the *"Independent Verification Survey Data Sheet,"* form IVP 1000.

[16] Catalog each surface media sample on a *"Chain of Sample Custody,"* form GJO 1512.

[17] Submit the surface media samples for laboratory analysis.

[a] Request "Isotopic Activity by Alpha Spectroscopy" to include the isotopes

- Pu-238,
- Pu-239,
- Pu-240/241,
- Am-241,
- U-234,
- U-235, and
- U-238

6.0 RECORDS

6.1 Records Generated by This Procedure

A. *"Independent Verification Survey Data Sheet,"* Form IVP 1000

B. *"Chain of Sample Custody,"* Form GJO 1512

6.2 Supervisory Review

[1] Review the completed documentation to ensure completeness, accuracy, legibility, and reproducibility.

1. IV Contractor records shall conform with the MACTEC-ERS *General Administrative Procedures Manual* (MAC-1000), Section 3.0, "Records Management Procedure."

[2] Compare the data recorded with specified limits and procedural controls to determine if trends are developing or unexpected results were obtained.

[3] Notify the IV Sampling Field Team Leader of any trends or unexpected results.

[4] Record the applicable File Index Number in the bottom right hand corner of each record generated by this procedure.

6.3 Record Disposition

[1] Maintain the documentation generated by this procedure as S-level quality records.

[2] Transmit completed and reviewed records generated by this procedure to the IVP records custodian for storage and maintenance in accordance with the applicable records management plan and Working File Index.

1. IV Contractor records shall be managed in accordance with the records management procedure provided in the MACTEC-ERS *General Administrative Procedures Manual* (MAC 1000) and the applicable project records Working File Index.

7.0 REFERENCES

A. Z000100, *"Independent Verification Sampling and Analysis Plan for Building 779 Cluster."*

B. 10 CFR 835, *"Occupational Radiation Protection"*

C. DOE/EH-0256T, *"DOE Radiological Control Manual"*

D. DOE Order 5400.5, *"Radiation Protection of the Public and the Environment."*

8.0 FORMS AND APPENDICES

8.1 Forms

A. *" Independent Verification Survey Data Sheet,"* Form IVP 1000

B. *"Chain of Sample Custody,"* Form GJO 1512

8.2 Appendices

A. *"Surface Contamination Guidelines for Various Isotopes"*

B. *"Chain of Sample Custody,"* Form GJO 1512

8.0 FORMS AND APPENDICES

8.1 Forms

A. *" Independent Verification Survey Data Sheet,"* Form IVP 1000

B. *"Chain of Sample Custody,"* Form GJO 1512

8.2 Appendices

A. *"Surface Contamination Guidelines for Various Isotopes"*

B. *"Chain of Sample Custody,"* Form GJO 1512

Appendix A

Surface Contamination Guidelines for Various Isotopes

Page 1 of 1

Survey Method [3]	Isotopes [1]	Average [2] [3] dpm/100 cm^2	Maximum [2] [4] dpm/100 cm^2	Removable [2] [5] dpm/100 cm^2
TRU Alpha	Transuranics, Ra-226, Ac-227, Ra-228, Th-228, Th-230, Pa-231	100 alpha	300 alpha	20 alpha
Uranium Alpha	U-Natural, U-235, U-238, and associated decay product, alpha emitters	5,000 alpha	15,000 alpha	1,000 alpha
Low Energy Beta	H-3 and other beta emitters with E-max < 0.15 MeV	NA	NA	1,000 beta
All Other Beta	Beta-gamma emitters (radionuclides with decay modes other than alpha emission or spontaneous fission) except Sr-90 and other noted above. [6]	5,000 beta	15,000 beta	1,000 beta

(1) The values in this table apply to radioactive contamination deposited on, but not incorporated into the interior of the contaminated item.

(2) As used in this table, dpm (disintegrations per minute) means the rate of emission by radioactive material as determined by correcting the counts per minute measured by an appropriate detector for background, efficiency, and geometric factors associated with the instrumentation.

(3) Where surface contamination by both alpha-and beta-gamma-emitting radionuclides exists, the limits established for alpha- and beta-gamma-emitting radionuclides apply independently.

(4) The levels may be averaged over 1 square meter provided the maximum activity in any area of 100 cm^2 is less than three times the allowable average values.

(5) The amount of removable radioactive material per 100 cm^2 of surface area should be determined by swiping the area with dry filter or soft absorbent while applying moderate pressure and the assessing the amount of radioactive material on the swipe with an appropriate instrument of know efficiency.

(6) This category of radionuclides includes mixed fission products, including the Sr-90 which is present in them. It does not apply to Sr-90 which has been separated from the other fission products or mixtures where the Sr-90 has been enriched.

Appendix B
"*Chain of Sample Custody*," Form GJO 1512
Page 1 of 1

Grand Junction Office
2597 B 3/4 Road
Grand Junction, Colorado 81503
Telephone (970) 248–6000

Chain-of-Sample Custody

1. Page_____ of_____
2. Date____________

3. Project Name ______________________________
4. Site Location ______________________________
5. Sampler *(print name)* ______________________________

6. Sample No.	7. Date	8. Time	9. Sample Location	10. Sample Matrix	11. Containers						12. Remarks	13. Condition Received

14. Relinquished by *(signature)*	Date	Time	Relinquished by *(signature)*	Date	Time	Relinquished by *(signature)*	Date	Time
Received by *(signature)*	Date	Time	Received by *(signature)*	Date	Time	Received by *(signature)*	Date	Time

15. Method of Shipment	16. Laboratory/Destination	17. Airbill or Receipt Number

18. For Contract Laboratories Only—Receiver to sign, date, and return form by mail or with analytical data package

Company Name ______________________ Received by ______________________ Date __________

GJO 1512
5/97

Preparation instructions on back of form.

Distribution: Original accompanies shipment, copies to relinquisher.

Department of Energy, Grand Junction Office

INDEPENDENT VERIFICATION PROGRAM
FIELD OPERATING PROCEDURE

Managing Electronic Data

IVP-RFETS-05
REVISION: 02-12-99

EFFECTIVE DATE: *February 12, 1999*

APPROVED BY:

Technical Task Manager: Steve Rima / [signature] Date: 2/10/99
(Print and sign name)

IV Program Manager: Deb Richardson [signature] for MCB Date: 2/10/99
(Print and sign name)

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TABLE OF CONTENTS

1.0 INTRODUCTION

1.1 Purpose

This procedure provides instruction to personnel for downloading and managing electronically generated data.

1.2 Scope

This procedure addresses the management of electronically generated data logged with the E-600 portable radiation survey instrument.

1.3 Applicability

This procedure is applicable to IVC personnel performing E-600 instrument data downloads to a personnal computer.

1.4 Definitions

None

1.5 Responsibilities

1.5.1 IV Contractor Field Team Leader

The Field Team Leader is responsible to provide technical oversight and supervisory review functions for operations directed by this procedure.

1.5.2 IV Contractor Sample Team Personnel

Sample team personnel who will use a personal computer to download electronically generated data logged with the E-600 portable radiation survey instrument are responsible to ensure that the data is downloaded, saved, and safeguarded and to clear the instrument's data log before proceeding to a new survey unit.

2.0 PRECAUTIONS, LIMITATIONS AND NOTES

2.1 Precautions

None

2.2 Limitations

None

2.3 Notes

None

3.0 PREREQUISITE ACTIONS

4.0 DOWNLOADING and RETRIEVING E-600 LOGGED DATA

[1] Turn on the IBM® compatible PC.

[a] Start the Microsoft Windows®

[b] Start the E-600 Interface Program

[2] Disconnect the bar code scanner cable from the 7-pin connector on the front of the E-600.

[3] Connect the to the 9-pin seriel port on the computer.

[4] Connect the other end of the computer interface data cable to the 7-pin circular receptical on the front of the E-600.

[5] Turn the E-600 instrument on in the CHECK mode.

[6] Select ***Log*** from the E-600 Interface Program ***Main*** menu

[a] Select ***Retrieve Log Data*** from the E-600 Interface Program ***Log*** menu.

Note *The data stored or logged in the E-600 memory will be automatically downloaded to a comma delimited ASCII data file named MMDDYY.ADD (e.g., 021299.005, where the name is the date the data was logged and the extension is the address of the E-600).*

[7] View the data file to verify that it has been properly recorded.

[a] Select ***Log*** from the E-600 Interface Program ***Main*** menu

[b] Select ***View Log Data*** from the E-600 Interface Program ***Log*** menu.

[8] Save the data file on a floppy disc and on the computer's hard disc.

[a] Name the data file with the survey unit number and iteration code (e.g., 779101a, 729002b, etc.)

[9] **WHEN** the instrument's data has been succesfully downloaded and saved, **THEN** clear the log data stored in the E-600 to prevent double entries in the ASCII data files.

[a] Select ***Log*** from the E-600 Interface Program ***Main*** menu

[b] Select ***Clear Log Data*** from the E-600 Interface Program ***Log*** menu.

[10] Disconnect the computer interface data cable from the 7-pin circular receptical on the front of the E-600.

[11] Turn the E-600 instrument OFF.

[12] Print a hard copy of the ASCII data file for the IVP records.

5.0 RECORDS

5.1 Records Generated by This Procedure

A. ASCII data files of data electronically logged in the E-600

5.2 Supervisory Review

[1] Review the completed documentation to ensure completeness, accuracy, legibility, and reproducibility.

1. IV Contractor records shall conform with the MACTEC-ERS *General Administrative Procedures Manual* (MAC-1000), Section 3.0, "Records Management Procedure."

[2] Compare the data recorded with specified limits and procedural controls to determine if trends are developing or unexpected results were obtained.

[3] Notify the Sampling Field Team Leader of any trends or unexpected results.

[4] Record the applicable File Index Number in the bottom right hand corner of each record generated by this procedure.

5.3 Record Disposition

[1] Maintain the documentation generated by this procedure as S-level quality records.

[2] Transmit completed and reviewed records generated by this procedure to the IVP records custodian for storage and maintenance in accordance with the applicable records management plan and Working File Index..

1. IV Contractor records shall be managed in accordance with the records management procedure provided in the MACTEC-ERS *General Administrative Procedures Manual* (MAC 1000) and the applicable project records Working File Index.

6.0 REFERENCES

A. Z000100, *"Independent Verification Sampling and Analysis Plan for Building 779 Cluster"*

B. *E-600 Interface Program User Manual*

7.0 FORMS AND APPENDICES

7.1 Forms

None

7.2 Appendices

None